To

MY FRIEND,

JAMES E. MOONEY,

PRESIDENT OF THE AMERICAN OAK LEATHER CO., CINCINNATI, OHIO,

WHO HAS DEVOTED HIS LIFE TO THE MANUFACTURE OF LEATHER OF ALL KINDS, AND HAS DONE MORE THAN ANY OTHER MAN TO BRING TANNING EXTRACTS INTO GENERAL USE,

I DEDICATE THIS BOOK.

PREFACE

TO THE SECOND EDITION.

AFTER nearly two years spent in the thorough revision, and the almost re-writing of this book, necessary on account of the many improvements in the manufacture of leather, the time has come to prepare the preface.

The object which the author has kept constantly in view has been to supply his readers with practical and useful information upon such subjects as come within the scope of the book, and in as condensed a form as possible. He has given no space to mere theorizing, as he feels that he can be of greater use in setting forth good technical information, combined with suitable illustrations. The reader of a work of this character is necessarily looking for help in his particular field of industry, and is much better pleased to find the subject clearly expounded than to wade through pages of purely theoretical matter.

The tanner's trade, like most other trades, has in the past been followed and carried out by rule of thumb rather than by scientific guidance. But this is steadily and rapidly changing; chemistry having become the handmaid of all the industries, the chemist is necessarily a part of the personnel of every large tannery, and in all departments of leather manufacture he is making his influence felt for good.

During the past fifteen years the leather industry of the United States has made greater strides than in all of the previous centuries of its existence. The chrome process has been introduced, and tanning extracts have come into general use,

and the world largely owes its progress, in these directions, to the United States. True, Germany led in the theoretical research regarding the use of chrome, but it remained for the United States to make this invention a practical success.

We are ever traveling onward, and while it may by some be considered that the duty of 15 per cent. on hides and calf-skins might be an impediment, it can readily be overcome by our superior machinery and skill, and thus will we be able still to hold our foreign trade.

While this industry has progressed from the simplest and most primitive to its present state, it is not yet perfect. The author would therefore admonish every manufacturer of leather to be on the lookout for all new improvements, and when found to be practicable to adopt them, as only in this way can he keep "up-to-date," and thus be saved from being relegated to the rear. It is much easier to go backward than to go forward.

He desires especially to acknowledge his indebtedness to the *Shoe and Leather Reporter* for much valuable data gathered from its columns, and to all other trade papers from which he has taken any matter, not specially acknowledged in the body of the book.

CHARLES THOMAS DAVIS.

WASHINGTON, D. C.,
605 Seventh Street, October 1, 1897.

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THE MANUFACTURE OF LEATHER.

CHAPTER I.

WATER AND PUMPS.

TANNERIES and currying shops are not, in the United States, located, as a rule, upon rivers and streams, as they are in many parts of Europe. There are advantages in being located upon rivers and streams, in having at nearly all times a uniformity in the hardness or softness of the water; but there are also disadvantages in the great variations of its temperature. The idea in the United States is to have the tannery or currying shop located upon a railroad switch, so as to have easy and cheap communication with all parts of the country, and hence the softness or hardness of the water is made a minor detail. If hard, it takes more tan bark or extract to do the tanning than if it were soft, and more dyeing materials to do the coloring.

However, water occupies an important position in tanning, it being employed, on the one hand, for washing, cleansing, and preparing the raw hides, and on the other, as a solvent for all the tanning materials and as a diluent for all the coloring and dyeing materials used.

We shall here briefly discuss the most important admixtures of water, and their influence in tanning.

All naturally occurring water contains smaller or greater quantities of alkaline and earthy alkaline salts, and carbonic acid in solution. There is no entirely pure well or river water, *i. e.*, free from all admixtures. By leaving out of consideration the small quantity of ammonium nitrite, organic substances,

etc., held in solution by rain water, the latter might be considered chemically pure water.

Water is distinguished as *hard* and *soft*, according to the quantity of earthy alkaline salts it contains, the amount of mineral substances varying from 1 milligrm. to 1 grm. per litre. The principal admixtures occurring in water are, as mentioned above, the alkalies, such as potassium, sodium, alkaline earths, lime, and magnesia; the oxides of a few heavy metals in combination with ordinary mineral acids, sulphuric, nitric, phosphoric, carbonic, and hydrochloric acids. The gases held in solution are chiefly carbonic acid and atmospheric air, sulphide of hydrogen occurring but seldom.

The admixtures of spring and well water consist principally of the constituents of the layers of earth through which it percolates. Those, for instance, contained in the waters flowing through the dolomitic stratification may be considered as pure solutions of the dolomitic rock, consisting as they do of calcium carbonate, magnesium carbonate, and silicic acid, the quantity of all other constituents being so small as to make it almost impossible to determine them by quantitative analysis. The waters percolating through the basalt and the new red sandstone contain principally calcium carbonate, magnesium carbonate, silicic acid, considerable quantities of free carbonic acid and small quantities of common salt, calcium sulphate, and sodium carbonate. The total dry residue of waters coming from the lias formation varies between 268 and 516 milligrms., the principal constituents being in this case also calcium carbonate, 200 to 400 milligrms. per litre, magnesium carbonate (varying from 30 to 90 milligrms. per litre), sodium carbonate, free carbonic acid, etc.

Besides these natural constituents, spring and well water, but especially the latter when in large cities or in the neighborhood of dumping places for all kinds of offal, the soluble substances of which percolate through the soil, contain frequently in solution organic products of decomposition of organized bodies such as bacteria, fungi, alkaline nitrates, especially ammonia,

and alkaline salts. Though such water, for hygienic reasons, is generally unfit for drinking purposes, it may be put to technical use.

In determining the qualities of water for tanning purposes, two points, as mentioned, must be taken into consideration, viz., first, the behavior of the water when used as a solvent for the tanning materials, and second, whether it is adapted for preparing the hides for tanning. If the water is to be used for dissolving or extracting tanning materials containing tannic acid, the earthy alkalies, lime and magnesia combinations, exert a decidedly injurious effect, as, by forming insoluble combinations with the tannic acid, they render a part of the tanning material ineffective. If the water is to be used for soaking, cleansing, and washing the hides, mineral admixtures may exert a favorable influence. In speaking of the chemical properties of the skin tissue and the coriïn, it will be shown that some of the alkaline salts exert a dissolving influence upon the intercellular substances or coriïn, the effect of small quantities of alkalies being an increased solution of coriïn in acids. From this we may draw the conclusion that hard water promotes the soaking of dried hides, but that a part of the coriïn is withdrawn from the skin tissue if the hide is too long subjected to the action of the water.*

Hides intended for sole leather are *swelled* or "plumped" in order to cause them to be better adapted to the absorption of the tanning material. In case the natural swelling is not suffi-

* Eitner (see Der Gerber, 1877, No. 178, and Dingl. Polyt. Journ., ccxxiv, 524) has made experiments as regards the effect of different inorganic constituents of water upon the depilated skin, using various solutions of alkaline, calcium, and magnesium salts in distilled water. He found that water containing only calcium chloride and magnesium chloride had almost no swelling effect, and distilled water scarcely any, it being further remarked that carbonic acid, and consequently water containing bicarbonates, exerted a swelling effect upon the hide. Alkaline chlorides and alkaline earths, such as magnesium chloride, potassium and sodium chlorides, have no swelling effect whatever, even nullifying it partly. Calcium and magnesium sulphates proved the best swelling materials for hides, this explaining the advantageous effect produced in swelling by a careful addition of sulphuric acid to water containing much bicarbonate.

cient, it is assisted by the use of inorganic as well as organic acids. This swelling process is accelerated, and the falling back of the hides into their previous state prevented by the use of hard water.

Soft water is preferred for the manufacture of upper leather, since the hides must not be swelled so much as those for sole leather, as otherwise the smooth cut would be injured.

The temperature of the water used for preparing the hides must also be taken into consideration. Generally speaking, the water should be as cold as possible for the manufacture of sole leather to prevent the skin fibre from being softened too much.

It is also of importance that the water should not be exposed to too great variations in temperature in summer and winter; 46 to 50° F. may be designated as the most favorable temperature. Spring water coming from deeper strata of the soil, and possessing consequently a more even temperature, is to be preferred to river water.

As regards the chemical examination of water, we refer the reader to the following

METHODS FOR DETERMINING THE CONSTITUENTS OF WATER.

We cannot enter upon a description of the different qualitative and quantitative methods of determining the constituents of water; but will only briefly describe a few examinations of importance in tanning, and those who may desire a full description of the methods and apparatus employed, are referred to the treatises of Wanklyn and Frankland on Water Analysis.

The qualitative examinations of water as to its admixtures of lime, magnesia, alkalies, chlorine combinations, sulphuric and carbonic acids, the larger or smaller quantity of which generally determines its character, can be executed in the following manner:

1. The chlorine combinations are shown by the formation of a white precipitate when treated with nitrate of silver in nitrate solution.

2. Sulphuric acid and sulphates are recognized by the formation of a white precipitate with barium chloride.

3. Carbonic acid is present when the addition of clear lime-water gives a white precipitate.

4. The presence of silicic acid, lime, and magnesia, by evaporating to dryness with an addition of hydrochloric acid in a platinum dish of a capacity of about one litre. The residue is taken up with hydrochloric acid and water, the portion remaining undissolved being silicic acid. The lime can be separated as calcium oxalate from the filtrate with ammonium oxalate. After removing the calcium oxalate by filtration and evaporation of the filtrate, the magnesia is precipitated with ammonium phosphate as ammonium magnesium phosphate.

5. Organic substances are shown by adding a few drops of potassium permanganate and some pure sulphuric acid. If organic substances are present, the potassium permanganate, added drop by drop, is decolorized until all the organic substances are completely oxidized.

6. Determination of the entire residue. One litre is carefully evaporated to dryness, requiring from twenty-four to twenty-six hours, in a platinum dish, the weight of which has been previously determined. The residue is dried at 356° F. until a decrease in weight no longer takes place.

7. A determination of hardness with alcoholic soap solution serves in most cases for tanning purposes as a substitute for a quantitative analysis. We give, therefore, a short description of it.

The process of determining the hardness of water by a soap solution of a determined percentage, which was introduced by Clark, is a very simple one. By an addition of soap solution to water containing too much lime or magnesia, a white precipitate of lime or magnesia soap insoluble in water is formed as long as calcium or magnesium salts are present. When an excess of soap solution has been added, the end of the reaction is indicated by the formation of lather on shaking the fluid.

The effective value of the soap solution is determined by

testing it with a lime solution of a determined percentage. Clark's method is, according to Faisst and Knauss, executed in the following manner:—

The soap solution required for titration is obtained by dissolving 30 grms. of dried soda soap in 3 litres of alcohol of 90 per cent. The turbid solution is filtered and preserved for use. 200 grms. of this concentrated solution are first compounded with 150 grms. of water (in order to reduce the alcohol to the strength of 56° Tralles, which has been proven to be the most suitable), and then with 130 grms. of spirit of wine of 56° Tralles. 45 c.c. of the solution thus obtained are required for the precipitation of 12 milligrams. of lime in 100 c.c. of water. The exact titre of this solution must be further determined and corrected by adding concentrated soap solution, or alcohol of 56° Tralles, so that 12 milligrms. of lime require exactly 12 milligrms. of soap solution. For the determination of the concentration of the soap solution a neutral solution of calcium chloride is used, which is obtained by dissolving 0.214 grm. of calcium carbonate in hydrochloric acid, evaporating the solution, and dissolving the residue to 1 litre. 100 c.c. of this solution contain 12 milligrms. of calcium oxide, or an equivalent quantity of calcium chloride. With this solution the soap solution is tested, and the latter sufficiently diluted, so that exactly 45 c.c. are required to produce, when brought together with 100 c.c. of lime solution, and shaken, a white lather remaining for about five minutes.

The process of determining the hardness is as follows: A distinction is made between "total hardness" and "permanent hardness." The hardness of water not heated is called "total hardness," and the hardness produced by the earthy sulphates is termed "permanent hardness," because unaffected by ebullition; the term "temporary" or "changeable hardness," is also frequently used to denote the hardness produced by the earthy carbonates, because removable by ebullition.

1. *Determination of Total Hardness.*—100 c.c. of water are measured with a pipette into a test tube, having a capacity of

200 c.c., and provided with a ground glass stopper. Water containing much lime is previously diluted with distilled water, so that to a determined number of cubic centimeters (10, 20, or 30) of the water to be tested, 90, 80, or 70 c.c. of distilled water are added. A mark on the tube indicates the point to which it is filled by 100 c.c. of the fluid.

Before adding the soap solution, the free carbonic acid is partly removed by shaking the water.

As most well-waters have more than 12° of hardness, only 10 c.c. of the water to be tested are measured off, and diluted to the mark with distilled water. Titrated soap solution is then slowly added from a burette until, after vigorous shaking, a dense delicate lather is formed which will hold for about five minutes. The soap solution is first added in half cubic centimeters and later on in drops. The shaking must always be done in the same manner, and the volume of the fluid amount to 100 c.c. before the soap solution is added. Should a second experiment be necessary, the same quantity of water is used, or, in case but little soap solution has been consumed for the diluted water (10 : 100), correspondingly more (25 to 50 c.c.), so that the quantity of soap solution, which should previously be approximately calculated, does not exceed 45 c.c. With the assistance of the following table, the respective degree of hardness which, in case the water has been diluted, must be multiplied with the corresponding figure, is found from the cubic centimeters of soap solution consumed. (The corresponding figure is found by dividing 100 by the cubic centimeters used for the experiment.)

3.4	c.c.	soap	solution	consumed.....	0.5	degree	of hardness.
5.4	"	"	"	.....	1.0	"	"
7.4	"	"	"	.....	1.5	"	"
9.4	"	"	"	.....	2.0	"	"

The difference of 1 c.c. of soap solution = 0.25 degree of hardness.

11.3	c.c.	soap	solution	consumed	.....	2.5	degree of hardness.
13.2	"	"	"	.....		3.0	" "
15.1	"	"	"	.....		3.5	" "
17.0	"	"	"	.....		4.0	" "
18.9	"	"	"	.....		4.5	" "
20.8	"	"	"	.....		5.0	" "

The difference of 1 c.c. of soap solution = 0.26 degree of hardness.

22.6	c.c.	soap	solution	consumed	.....	5.5	degree of hardness.
24.4	"	"	"	.....		6.0	" "
26.2	"	"	"	.....		6.5	" "
28.0	"	"	"	.....		7.0	" "
29.8	"	"	"	.....		7.5	" "
31.6	"	"	"	.....		8.0	" "

The difference of 1 c.c. of soap solution = 0.277 degree of hardness.

33.3	c.c.	soap	solution	consumed	.....	8.5	degree of hardness.
35.0	"	"	"	.....		9.0	" "
36.7	"	"	"	.....		9.5	" "
38.4	"	"	"	.....		10.0	" "
40.1	"	"	"	.....		10.5	" "
41.8	"	"	"	.....		11.0	" "

The difference of 1 c.c. of soap solution = 0.294 degree of hardness.

43.4	c.c.	soap	solution	consumed	.....	11.5	degree of hardness.
45.0	"	"	"	.....		12.0	" "

The difference of 1 c.c. of soap solution = 0.31 degree of hardness.

Suppose 50 c.c. of the water to be tested had been placed in the test tube and diluted with 50 c.c. of distilled water, and had consumed 22.6 c.c. of soap solution for the formation of lather. According to the table these 22.6 c.c. of soap solution correspond to 5.5 degrees of hardness. This figure 5.5 is multiplied by 2, which gives 11 as the actual degree of hardness of the water. (The figure 2 is obtained by dividing 100 c.c. by 50 c.c.)

2. *Determination of Permanent Hardness.*—For the determination of the permanent hardness 500 c.c. of water are boiled in a sufficiently large matrass for at least one and a half hours, a part of the evaporated water being replaced by distilled water. The boiled water, when cold, is poured into a flask having a capacity of 500 c.c., and the matrass rinsed out with distilled water, the rinsings being added to the water in the flask. The latter is then filled with distilled water up to the mark, and the entire contents filtered through a dry filter into a dry test tube. The degree of hardness of a definite number of cubic centimeters is then determined in the above manner.

Clark was the first to introduce the term "degrees of hardness," 1 degree corresponding, according to him, to 1 part (grain) of calcium carbonate or its equivalent of another calcium salt, or equivalent quantities of magnesia or magnesium salts in 70,000 parts (= 1 gallon) of water, At the present time 1 degree of hardness is suitably estimated as equal to 1 part of calcium oxide in 100,000 parts of water. The German degrees of hardness are reduced to English by multiplying the degrees found by 5 and dividing by 4, the reduction of English to German degrees being *vice versa* accomplished by multiplying by 4 and dividing by 5. In France 1 degree of hardness is calculated as equal to 1 part of calcium carbonate in 100,000 parts of water, 1 degree of hardness being therefore:

In Germany = 10 milligrams of calcium oxide in 1 litre of water.
In France = 5.6 milligrams of calcium oxide in 1 litre of water, or an equivalent quantity of magnesia or magnesium salts.

SOFTENING WATER.

There have been proposed numerous methods for softening and purifying water. Some effect a chemical reaction, others act by a mechanical process, while others, such as oak sawdust, act both chemically and mechanically; the tannic acid which it contains forming tannates of lime and magnesia by the decomposition of the carbonates, and these tannates, on account of their low specific gravity, float about the water. The sulphates and

chlorides are prevented from agglutinating into a crust by the mechanical action of the sawdust. Such anti-incrustation remedies as oil-cake, potatoes and other starchy matter, glue, offal of hoofs and horns, tobacco juice, Irish moss, peat, tow, hemp, etc., envelop the particles of lime and deposit them in the form of sludge.

Clay also precipitates the lime salts in the above manner. Tannic acid does not act upon sulphates and chlorides, neither is sulphate of lime altered by acetic acid, the action of both these acids being to convert the carbonates into soluble acetates, and of course in this action both tannic acid and acetic acid are absorbed and the work which they might do in the tan pit is lessened. Both tannic and acetic acids are employed to purify water, but the employment of these acids is expensive, and their place can be taken by cheaper acids and alkalies.

Borax is the best agent that can be used for purifying water for the use of tanners and curriers. Its price is now about 5½ cents a pound, and 5 or more pounds of borax will soften one thousand gallons of water, such as is used by the average tanner. Some harder waters will require a little more borax, and at the present price of hemlock and oak bark, will save him on an average about $1.50, that is, the tanner by buying about twenty-five cents worth of borax will be $1.50 in pocket.

To soften one thousand gallons of water 5 pounds of borax are used. It is dissolved in boiling water and poured into the vat or tank under vigorous stirring.

The laundry men have tried all sorts of chemicals for softening the water which they use for washing clothes, and they have found none so harmless, cheap and effective as borax. The large packers of this country have tried all sorts of chemicals for preserving their meats, but are now using borax because of its cheapness and preserving qualities.

The foregoing are two reasons why the tanners of all kinds of hides and skins should use borax in their soaks, as the soaks are thus kept fresh and prevented from becoming putrid or foul, with the consequent withdrawing of valuable gelatine from the hide or

skin under treatment. By the use of borax in the soaks a firmer, heavier and more solid leather can be produced by this saving of gelatine. In the leaches borax is equally invaluable for softening the water before it goes on the tan bark, because of the large saving of money which it effects. Of course the tannic acid will soften the water, but the hardness of the water has to be overcome by the tannin before the water itself can become effective.

Borax is one of the gentlest of the alkalies and is one of the most perfect of the cleansers. It will clean a hide or skin thoroughly, which is a most desirable point in tanning, and by rendering the water soft it will act upon the tan bark quickly under any system of leaching.

Borax is largely used by dyers and colorers of leather for rendering the water soft and also as a mordant, and thus preventing the absorption of too much coloring matter or dry stuffs, and giving a more uniform color and lustre.

Borax is very largely used by the manufacturer of glazed kid, not only in soaking and cleansing the skin, but it is a fine mordant and gives a uniform color to the skins. It is well known that in the treatment of colored goods in the laundry, borax is used in the water to prevent the colors from running; it fixing them. Borax has heretofore been a little too high in price to be generally used by the tanner or currier, but now the price has fallen so low as to bring it within his reach, and he should improve his opportunity.

It was formerly imported from abroad, but since the discoveries of this substance on the Pacific Coast nearly all the borax used in this country comes from there, and as a consequence the price has fallen to its present low point.

A clean hide or skin will tan more quickly than a dirty one, hence borax will hasten the tanning process and thus save time and money.

It is to be observed that water evaporates at all temperatures, and its solvent properties far exceed those of any other known liquid. The softer the water the greater its solvent properties.

A very large proportion of all the different salts are more or less soluble in it, the solubility increasing generally as the temperature rises, so that a hot, saturated solution deposits crystals on cooling. There are a few exceptions to this rule, one of the most remarkable of which is common salt, the solubility of which is nearly the same at all temperatures, the hydrate of lime (slaked lime) being more soluble in cold than in hot water, sulphate of lime being also less soluble in hot than in cold water, and insoluble at 302° F., or between 284° and 302° F.

Water is one of the most potent agencies with which the tanner has to deal, and the harder the water the less profit there will be in the tanning and currying industries.

PUMPS.

The methods of obtaining water in tanneries vary greatly, and we will here enter briefly into the subject of pumps.

There is no mention made in history of pumps prior to the year 200 B. C. The Chinese cannot claim any priority in this special branch, which is peculiar, when we consider their manner of irrigation. A pump is a rarity with them.

A tanner's pump is not a very intricate machine, and its parts are comparatively few. But its action, or want of it, sometimes makes it seem most mysterious. To those readers who have not considered the question of water dispensation, the remark that pumping machinery stands prominent among the various branches of engineering may seem to allow of discussion. A few instances will very soon give ample proof. How could our coal be obtained and our mines worked, if not for the pumping plant?—our water supply obtained, or our sewage and chemical works carried on? When man enters Nature's store-house in search of wealth, he finds water ever ready to dispute his supremacy; it may be in a constant stream, varying only with the season; oftentimes vast quantities are stored in crevices of the rocks. Some idea of the quantity of water raised will be given when it is known that often its weight is double and treble that of other material raised, and is frequently 30 per cent. in coal mines.

Rude nations have not possessed the machine, simple as it is, but have always resorted to a more laborious method to obtain water. In the early ages it does not appear to have been known to the Greeks or Romans. Although the pump was invented 200 B. C., it was not until the beginning of the seventeenth century that its true principles were understood; although in 1636 fire engines were built in Holland, and from which, as far as general principles are concerned, no improvements have been made.

The pumps commonly used for raising water from wells may be divided into two classes—lifting pumps and forcing pumps. The lifting pumps may be again subdivided into two varieties, namely, those with a hollow piston and those with a solid or plunger piston.

Lifting pumps with a hollow piston, called also atmospheric pumps. This variety, in its simplest form, consists of the following parts:

A cylinder or tube, in which is fixed a valve opening upward, and above which works a piston provided with a valve also opening upward. The part of the cylinder in which the piston works is called the body of the pump, and is the only part which need be bored with any great accuracy. The top of the cylinder may be opened or closed, it matters not which, but somewhere above the level to which the piston ascends there must be an orifice for discharging the water.

The action of the common atmospheric pump is so simple, and is so well known to every school boy, that it will be unnecessary here to dwell upon it. The cylinder is made of various materials, as wood, iron, or copper, and frequently the lower part below the fixed valve is a mere iron pipe furnished with a strainer at its lower extremity. The fixed valve in this kind of pump must be placed at such a level that the depth from it to the surface of the water in the well must never exceed the height of a column of water which will balance the atmospheric pressure or weight of the atmosphere. This weight is measured in the barometer by a column of mercury,

which varies in different parts of the world, and at different altitudes, from 28 to 31 inches. Thus, an atmospheric pump at the level of the sea may have its fixed valve several feet higher than a similar pump working on the top of a high mountain. The height at which the mercury stands in a barometer at any given place affords, in fact, a tolerably practical measure of the height to which water will rise in a vacuum when pressed by the external atmosphere. Thus, in theory, where the mercury stands in the tube of a barometer at a height of 30 inches, the sucker or fixed valve of an atmospheric pump may be placed 30 feet above the surface of water in a well. In practice, however, owing to imperfection of materials, fluctuations of level in the water, and other causes, this difference of level is too great, and should not really exceed 25 feet. In shallow wells, therefore, which are not more than about 27 feet in depth, the part of the cylinder or pump above the fixed valve need never exceed the length of the slope or space through which the piston works. In deep wells the ascending part of the cylinder above the body of the pump in which the piston works may be, theoretically, of any height. There are difficulties, however, connected with the valves in the movable piston which render it inconvenient to have the lift in this kind of pump much more than 100 feet. Whatever may be the height of the column of water above the movable piston, it is evident that the absolute weight of this whole column has to be lifted at each stroke of the piston, and for this reason atmospheric pumps, which are worked by hand, have scarcely any of the pump above the piston, as otherwise the weight of water to be lifted at each stroke would be too great for the power to be applied. This practically limits the height to which water can be raised from wells by common atmospheric pumps worked by hand to about 25 feet.

In deep wells, however, when pumps are worked by horse or steam power this objection does not apply, and if the power be sufficient to raise at each stroke the whole column of water above the piston, the length of the cylinder above this piston

is only limited by the practical considerations before alluded to in connection with the valves. It should be observed that the common atmospheric pump is seldom or never used in water-works for the purpose of raising water.

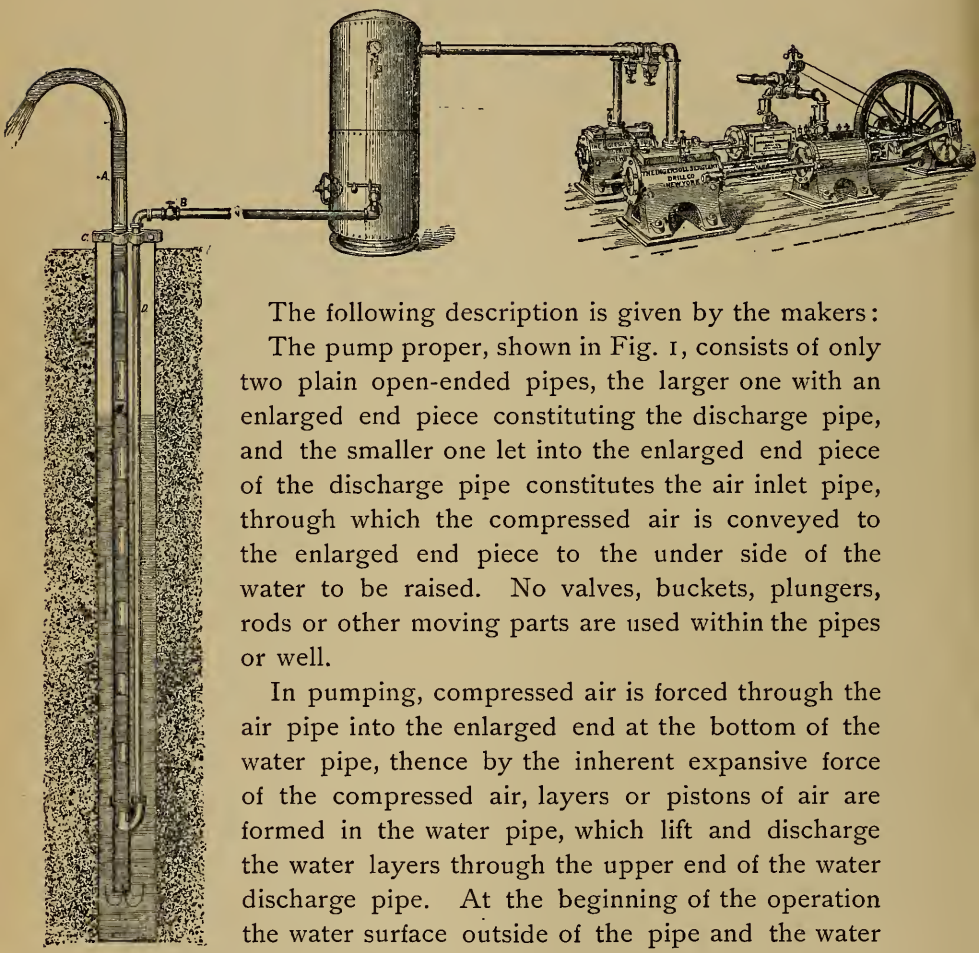
In the manufacture of waxed-calf, it is important that there should be a uniform temperature of the water in which the skins are soaked, and but few of the best manufacturers of this class of leather in France or Germany soak the skins in running water, because it is extremely cold in winter and warm in summer. In default of water from a live source, it may be drawn from a cistern; but, it may be said, it requires a large quantity of water, and that it will be costly to draw it to the surface. But it is very seldom that a tannery does not possess a horse or a steam engine; the horse is often idle in the stable; the engine has always a little power to spare above its requirements; or by means of the simplest machinery a double-action pump may be constructed and made to work by horse or steam power, and in this way there can be obtained from 2,000 to 2,500 gallons per hour or more if desired. There should be in the centre of the tannery or in one of the corners, a large tank raised at least six feet above the ground; the water, pumped into the tank, can be distributed at will over the whole establishment. The total expense may amount to $500 or $600; and such a figure is not large in consideration of the importance of the result: to have always at disposal a quantity of pure water and of an equal temperature.

If the tannery is a large one, and requires more water than can be furnished by this simple outfit, then, in our opinion, the tanner can not do better than to follow the example of the American Oak Leather Company, of Cincinnati, Ohio, and the Henry Lang Co., patent leather manufacturers of Newark, N. J., who have recently put in a pump with a pipe about 200 feet deep, for pumping water by compressed air by the Pohlé system.

Tanners and those interested in mining and hydraulics will be glad to have some account of the Pohlé system of raising

water from non-flowing wells, mines, etc., which has been introduced by the Ingersoll-Sergeant Drill Company, of No. 26 Cortlandt street, New York, N. Y.

FIG. 1.



The following description is given by the makers:

The pump proper, shown in Fig. 1, consists of only two plain open-ended pipes, the larger one with an enlarged end piece constituting the discharge pipe, and the smaller one let into the enlarged end piece of the discharge pipe constitutes the air inlet pipe, through which the compressed air is conveyed to the enlarged end piece to the under side of the water to be raised. No valves, buckets, plungers, rods or other moving parts are used within the pipes or well.

In pumping, compressed air is forced through the air pipe into the enlarged end at the bottom of the water pipe, thence by the inherent expansive force of the compressed air, layers or pistons of air are formed in the water pipe, which lift and discharge the water layers through the upper end of the water discharge pipe. At the beginning of the operation the water surface outside of the pipe and the water surface inside of the pipe are at the same level; hence the vertical pressures per square inch are equal at the submerged end of the pipe, outside and inside. As air is forced into the lower end of the water pipe, it forms alternate layers with the water,

so that the pressure per square inch of the column thus made up of air and water, as it rises inside of the water pipe, is less than the pressure of water per square inch outside of the pipe

Owing to this difference of pressure, the water flows continually from the outside to within the water pipe by gravity force, and its ascent through the pipe is free from shock, jar or noise of any kind.

These air sections or strata of compressed air form water-tight bodies, which, in their ascent in the act of pumping, permit no "slipping" or back flow of water. As each air stratum progresses upward to the spout, it expands on its way in proportion as the overlying weight of water is diminished by its discharge, so that the air section, which may have been say 50 pounds per square inch at first, will be only 1.74 pounds when it underlies a water layer of four feet in length at the spout, until finally this air section, when it lifts up and throws out this four feet of water, is of the same tension as the normal atmosphere; thus proving that the whole of its energy was used in work, and that this pump is a perfect expansion engine.

As the weight of the water outside of the discharge pipe (the head) is one-third greater per square inch than the aggregate water sections within the pipe when in operation, it follows that the energy due to this one-third greater weight is utilized in overcoming the resistance of entry into the pipe, and all the friction within it.

The Pohlé "air lift" pump gives ninety per cent. of efficiency from the air receiver in water pipes of large diameter, and as a rule, above eighty per cent. It retains this efficiency without repairs, or until the pipes rust through, whereas ordinary bucket and plunger pumps gradually lose efficiency from the first stroke they make, and lose it rapidly if the water contains sand or is acid in character. It has been estimated by competent experts, that under favorable conditions and large diameters of water and air pipes, 1,000,000 gallons of water can be raised 100 feet high with one and a half tons of good coal.

The air reservoirs are all strongly made of homogeneous

steel, tested and guaranteed at working pressures of 110 pounds; they are provided with the proper openings for inlet and outlet pipes, manhole and head, drain cocks, pressure gage and safety valve.

As the pump has no valves, no standing water remains in the pump column after the operation of pumping; it recedes into the well, and there is none left to freeze in cold weather. The capacity of the pump is unlimited, and with the proper proportions of air to the water, will work efficiently in pipes several feet in diameter. Estimates have been made which indicate that a thirty-inch pipe will deliver 16,660 gallons per minute, equal to 1,000,000 gallons per hour.

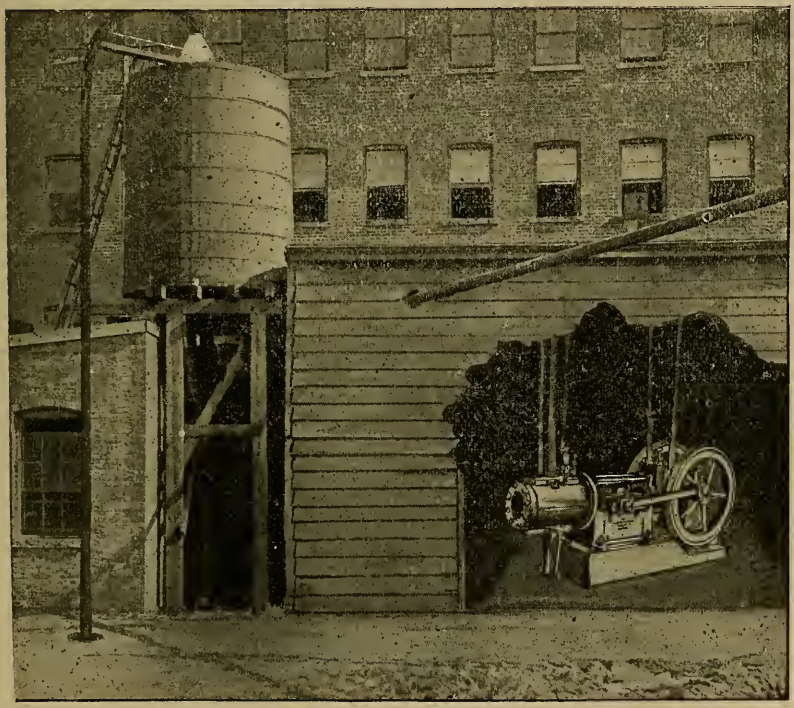
Experience has proved that by the use of this constant upward flow of water, artesian wells have been freed from their accumulated sedimentary deposits, as well as that lodged in the fissures and crevices of their wall rock, and have been thus made to yield greater quantities of water than they ever did before. For chemical uses, and for the liquids of the arts, there is no superior method to the "Air Lift." It is used successfully for raising sulphuric acid of high specific gravities, and is well adapted for ore leaching works, vinegar works, sugar refineries, dye works, tanneries, paper pulp works, etc.

This pump can be run with motor, water wheel, steam, oil or gas engine, or any other source of power.

It makes a much greater difference in the manufacture of waxed-calf than with any other class of leather, whether the water is hard or soft; still some prefer it soft, as it contains less calcareous substances than hard water, which is, as we have explained, often saturated with earthy salts. We have not attempted to give in this work the analyses of all the waters that trickle through our soil; it is the tanner's business to become acquainted with the quality of the water he has at his disposal, and to utilize it according to the elements it contains. Study the water; if it is soft the soaking will be done promptly, if it is hard it will take longer; but, any way, there is a certainty of arrriving at the same result; that is the aim.

Fig. 2 illustrates a Pohlé Air Lift Plant at the works of the Henry Lang Co., Patent Leather Manufacturers of Newark, N. J. It has recently been installed, and is giving entire satisfaction. The owners of the plant are enthusiastic over the work it is accomplishing. Its normal work is 10,000 gallons of water

FIG. 2.



DISCHARGE PIPE AND WATER TANK OUTSIDE OF HENRY LANG CO.'S FACTORY. RAISING WATER BY THE POHLÉ AIR LIFT.

every hour. The outfit comprises an Ingersoll-Sergeant Class "F" Air Compressor, an Air Receiver, and the Pohlé device in the well. The total depth of the well is 204 feet; diameter, six inches. The water level is twenty-five feet beneath the surface. The total lift from the level in the well to the tank is eighty-five feet. There is a steady supply of water.

When the conditions that surround other pumping outfits are compared with the simplicity of the Pohlé Air Lift method, the differences are vast in favor of the latter. This plant replaced a deep well pump which failed to give the necessary supply of water. In the illustration, Fig. 2, the view shows that the discharge pipe is exposed to all sorts of weather. That, however, is no disadvantage to the Pohlé Air Lift Pump, because when the pump is not in operation the water does not stand in the pipe, but falls back into the well, thus obviating the danger of freezing, rust, or other detrimental effects.

For a factory, tannery, brewery, paper-mill. or other establishments, the plant described can be installed at a reasonable outlay. The owners of this plant say in a letter that it is the best pump ever brought to their notice, and that it far exceeds their expectations.

CHAPTER II.

ANIMAL SKIN.

In the production of leather there are two classes of raw products with which the tanner has to deal; they are—

1. Hides and skins to be converted into leather, and
2. Materials by the aid of which the conversion or tanning is effected.

The object of the present chapter is to explain the structure of the skin and its behavior with reagents, without which knowledge an intelligent prosecution of the art of tanning is rendered difficult and at times hazardous.

The structure of animal skin consists of several readily distinguishable layers, which behave differently in a chemical as well as in a physical respect.

The upper part of the skin in which the coat of hair, wool, or fur is rooted, is termed the epidermis or cuticle, next beneath this is the corium or true-skin, and placed next to this is the under-skin.

The epidermis is composed of two layers:—

1. A tissue analogous to the corneous matter of the hoofs, horns, nails, and hair, and is composed of layers of nucleated epithelium cells, which when first formed are spherical, gradually becoming dry and flattened; the deeper layers being more distinctly cellular, while the outer layer is scale-like, and,

2. An inferior or basis-layer, Malpighi's net (*rete Malpighianum*), which consists of a layer of cells charged with fluid, and serves to feed or renew the horny tissue, being in its turn supplemented by vessels situated in the corium.

The epidermis does not combine with tannin or other substances by the agency of which leather is produced. Hence it

becomes useless to the tanner, and therefore the first process to which hides and skins are subjected by him is that for removing the hair and epidermis, and the portion of the skin thereby exposed is technically termed the "grain side."

The corium or true skin is divided into an intermediate layer next to the epidermis, and is the actual leather-skin.

Both are made up of interlaced bundles of connective tissue fibres, placed crosswise above each other, and running parallel with the surface of the skin; but being more or less filled with fluid matter that serves to renew the cuticle and maintain the skin in a pliant and moist condition. On treating the skin with water these matters are removed, and ultimately there remains but the fibrous portion saturated with water. In this state it appears semi-transparent, and if the water be expelled by a gentle heat, it assumes the physical appearance of horn, constituting only about 32½ to 33 per cent. of the raw hide.

The quality of the leather which can be produced from a skin depends upon the thickness, flexibility and strength of the corium, which exceeds the combined thickness of all the other layers forming the remainder of the skin.

A peculiar albuminoid substance (coriïn) is stored between the separate fibres of the corium, which substance in a dry state connects and cements together the raw skin fibres.

The under-skin consists of a loose connective tissue, in which the sweat and fat glands, the blood-vessels and muscular fibres are embedded. It is previously removed in the "beam house" of the tannery, and takes no part in the tanning process.

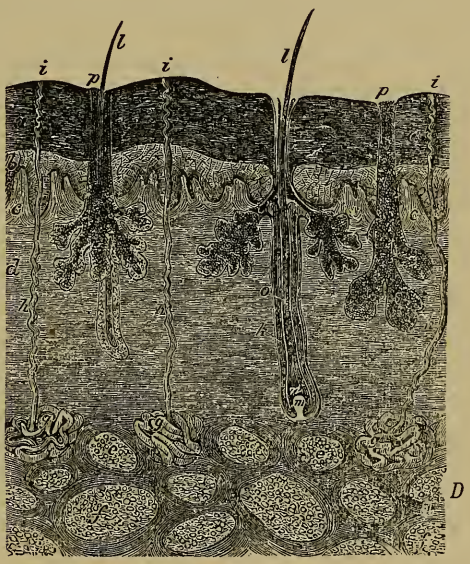
The side upon which the connective tissue of the under skin is located is technically designated as the "flesh side."

Fig. 3 shows an enlarged transverse section of the skin.

D is the connective tissue of the under-skin showing the sweat glands *g*, with the ducts *h*, through which this secretion passes out to the surface of the skin; *b* is the *Malpighi* net, and *d* the corium; *c*, papillæ of the skin; *e*, *f*, lobules of adipose tissue; *i*, the external orifices of the sweat or perspiratory glands; *k*, hair follicle; *m*, hair papilla; *n*, hair bulb; *o*, shaft of hair in hair follicle; *p*, openings of the sebaceous glands.

The horny layer of the epidermis, *a*, shows on different places, as at *l*, such structures as hair, wool, bristles, etc., which, as seen in the illustration, are not embedded immediately in the surface, but in capsules or shafts, called "*hair sacs*" or "*hair roots*," reaching from the epidermis to the actual corium. In these sac-like depressions the hair is fastened by means of "*hair bulbs*." The hair is coated with a protective layer of fat by small fat glands, the follicles of which enter the upper part of the hair-sac.

FIG. 3.



Malpighi's *rete mucosum* accompanies the bottom of the hair sac, the walls of the latter consisting of flat epithelial cells, which develop, only in another form, the hair itself.

The horny shaft of the hair is a section projecting above the skin, and when completely developed is provided with a minute epithelium, forming the upper skin of the hair.

In boiling with water the connective tissue fibres are converted into glue, the other constituents taking no part in the

glue formation. The chemical process taking place during the latter operation is not yet thoroughly understood. The relations of the glue-yielding tissues to the glue, seem to be similar to those existing between starch and paste. Starch, as well as the glue-yielding tissues, is a body of an equally pronounced nature, both being insoluble in cold water and remaining unaltered within certain limits. By boiling with water, they entirely lose their organized structure and form a solution, which on cooling separates, in glue, a colorless jelly, and in starch a body very similar to glue.

The skin, when slowly and completely dried in the air and stored in a dry place, can be kept for a long time. When dried by exposure to strong sun heat, it undergoes an alteration having an injurious effect. The fibres of such skin, after complete softening by soaking, which can only be accomplished with great difficulty, show very little strength. This excessive effect of heat may even cause the skin fibres to dissolve, in soaking, into a glue-like jelly, as has, for instance, been frequently observed in buffalo skins carelessly dried by exposure to strong sun heat.

Moist skins left to themselves decompose in a short time with the usual products of putrefaction making their appearance.

Covered with salt or immersed in strong brine, skins can be kept for a long time. By adding borax to the brine the quantity of salt used can be greatly reduced, one pound of borax doing the work of five pounds of salt, and it at the same time preserves the skin in much better condition than when salt alone is used.

The chemical and morphological constitution, as far as interesting to us, may be briefly given as follows:—

"The connective tissue fibres or fibrillæ form the morphological structure of the skin tissue, the intercellular substance or coriïn, as has been conclusively shown by Rollet,* and later by Reimer,† lying between them.

* Wiener Akademieberichte, 30, 37, 39, 308; and Dingl. Polyt. Journal, 149, 298.

† Dingler, Polyt. Journal, 143, 205.

The *intercellular substance* is an albuminous body, according to Rollet and Reimer, soluble in lime and baryta-water, and also, according to Reimer, in a 10 per cent. solution of common salt, while in one of greater or less concentration it remains insoluble. This behavior towards solutions of common salt and lime-water can therefore be used for separating it.

To prepare coriïn the skin is washed with water until all the soluble albuminoid substances are extracted. The skin is then placed in saturated lime-water six to eight days, which dissolves all the coriïn. The fluid is then filtered, and dilute acetic or hydrochloric acid added until the appearance of a slight acid reaction. The coriïn is separated as a flaky precipitate which, by standing quietly, settles on the bottom.

To obtain the coriïn perfectly pure and free from an admixture of cell elements, it is redissolved in lime-water, filtered, and again precipitated with acids. Coriïn precipitated from alkaline or common salt solution is constant in all respects; on detaching it from the filter gray or gray-white lamina are formed, which on exposure to the air assume a somewhat darker color. On shaking up with water, it swells up without actually dissolving, and is converted into a paste-like mass. By diluting the latter with water an opalizing fluid is obtained, which by standing forms a precipitate, nothing whatever remaining in solution. The addition of a small quantity of common salt increases the swelling capacity, while that of a larger quantity promotes solution, and that of a saturated solution of common salt effects precipitation. By adding spirit of wine to the substance dissolved or swelled in water, a flaky precipitate is separated.

After removing the spirit of wine the flakes act in the same manner as before. Precipitation may also be effected by ether, but as the precipitate for some time remains in contact with the ether, it can be swelled only with difficulty. Most of the alkaline salts and alkaline earths have, like common salt, a dissolving and swelling effect upon coriïn, small quantities of them increasing its solubility in water, which is a very important fact deserving special attention in tanning.

Most natural waters, as is well known, contain small quantities of alkaline salts and earths. In using such water for swelling, cleansing and washing the hides, the swelling influence which these salts have upon the coriïn must be taken into consideration.

In hard water containing much of these salts, the skins must remain for a shorter time than in soft water, *i. e.*, such as contains but a small quantity of salts, or none whatever.

In speaking of the use of water in the tannery, we have considered this point more closely, and the reader is referred to Chapter I.

Since by repeated treating with lime or baryta water, fresh quantities of soluble substances can be constantly withdrawn from the skin, it is not improbable that the intercellular substance is a product of decomposition of the connective tissue substance. This circumstance deserves consideration in depilating the skins and hides with lime, for if the latter remain too long in the lime, a part of the connective tissue is converted into soluble substance, which is lost in the succeeding cleansing of the hides.

Liming continued too long gives poor weight, and besides the strength of leather prepared from skins too long limed is impaired.

Coriïn is insoluble in acetic acid, and only partly soluble in dilute hydrochloric acid, the undissolved portion settling after long standing, as a flaky precipitate.

Coriïn is readily soluble in pure alkalies and solutions of alkaline earths.

Potassium ferrocyanide and ferricyanide produce no precipitation in acidulated or neutral solution, but effect precipitation when acting upon strongly swelled coriïn.

Ferric chloride, cupric sulphate, cupric chloride, and sugar of lead form no precipitate in neutral or slightly alkaline solutions, while it is produced by basic acetate of lead, excess of tannic acid or basic acetate of iron.

Coriïn is free from sulphur, since on melting the substance

with potassium hydrate no potassium sulphide remains behind.

From the composition found by the elementary analysis, Reimer derives the empirical formula $C_{30}H_{50}N_{10}O_{15}$.

The connective tissue substance* differs in many respects from the intercellular substance, but principally by being insoluble in lime-water, which, as we have seen, readily dissolves coriïn. It is dissolved by acetic, hydrochloric and other acids, but separates again on neutralization.

To prepare connective-tissue substance, place cleansed skin in acetic acid for some time. The skin swells up more and more, while the acetic acid dissolves a portion of the connective-tissue substance. The fluid becomes of a slimy nature and separates on being diluted with water, filtered and neutralized, to a flaky precipitate. To obtain the substance in a pure state, this precipitate is washed with lime-water in order to remove coriïn which may be present, and is again dissolved in acetic acid. Some potassium is added to the solution until only a very slight acid reaction is perceptible. The fluid is then saturated with common salt, the precipitate, after standing quietly, collecting upon the surface. It is filtered, and first washed with slightly acidulated water, and then with pure water, and finally dehydrated with alcohol.

Pure connective-tissue substance swells up when placed in water, and reassumes its original softness.

Acetic acid, as previously mentioned, dissolves connective-tissue substance, the solution containing the substance but it is not dissolved as glue. Potassium ferrocyanide and ferricyanide produce precipitates in the solution.

By boiling with water, the pure substance is readily converted into glue.

Pure lime water does not dissolve it; an essential difference from coriïn.

Tannic acid, basic acetate of lead, and basic sulphate of iron produce precipitates.

* Muspratt, Technische Chemie, Bd. III. 91.

The empirical formula $C_{15}H_{23}N_5O_6$ is derived from the elementary analysis.

This being the same composition as that found by Cramer for the fibroïn of silk, Reimer designates the matter extracted by acids from the skin as skin fibroïn.

The empirical formulæ calculated for coriïn and skin fibroïn give us no information as to the relation or close analogy of the two bodies to each other, their chemical constitution being still unknown.

The most important property of the skin fibre, which deserves special attention from a practical standpoint, is that it swells up strongly in one-half per cent. solutions of inorganic acids, and is entirely dissolved in somewhat concentrated acids if subjected sufficiently long to their action.

The swelling influence exerted by acids upon the skin fibres is, as is well known, used on the one hand to make the skin more sensitive for the reception of the tanning material, and, on the other, to effect the isolation of the compound bundles of connective-tissue fibres into separate fibres, increasing the surface thereby at the same time. It is self-evident that by carrying this swelling process too far, the strength of the fibre suffers injury.

For swelling the skin acetic and lactic acids are chiefly used; of these the latter is more effective than the former.

CHAPTER III.

VEGETABLE TANNING MATERIALS.

BUT few of the large number of vegetables containing tannic acid are used in tanning, though in modern times the number has been greatly increased by diligent researches made with a view to obtain cheaper tanning materials.

We shall here discuss the most important of such materials, first mentioning the inspissated vegetable juices which are imported.

Rutea is the inspissated juice of *Rutea formosa*, and is used for tanning only in the northwest of India.

Kino is the inspissated juice of *Pterocarpus erinaceus* and *marsupium*. Numerous varieties of kino are known in commerce, though the principal ones are those coming from Africa and Malabar. The African kino, which is the best, but seldom found in commerce, is the inspissated juice of *Pterocarpus erinaceus*.

The *Malabar*, or East Indian kino, is derived from *Pterocarpus marsupium*, a tree indigenous to Farther India, Malabar and Ceylon. Both varieties of kino are very rich in tannic acid, that of the latter being identical with gallotannic acid, it yielding, on heating, pyrogallic acid. On account of its high price, and the disagreeable red color it imparts to the leather, this tanning material is but little used.

Gambier is an extract from the leaves of *Uncaria gambir*. It forms cubical pieces $\frac{1}{24}$ to $\frac{1}{8}$ inch thick of a light and dark rust color or sometimes gray color, which float upon water and are very friable. Gambier is slightly soluble in cold water, but readily in hot. Its percentage of tannin is quite high.

Catechu, or *terra japonica*, is the dry extract from the heart

wood of a mimosa, *Acacia catechu*, growing in the East Indian islands. Its principal constituents are: Catechin, a brown substance which can be precipitated from its solution with glue, and catechutannic acid, which appears to be formed from the catechin by exposure to the air. It colors ferric oxide green, and gives a green-black precipitate with ferric salts. The value of catechu may be judged by its external color, hardness, taste, solubility in spirit of wine, etc. Genuine catechu melts upon the tongue, while non-genuine sticks to it. Adulterations with blood, sugar, etc., can be detected by the characteristic odor of these admixtures when burnt. The leather produced with catechu is not of a particularly good quality, it being of a dark color, permeable to water, spongy, and at the same time hard.

Gall-nuts are the richest in tannin of all tanning materials. They are morbid excrescences of the leaves and young branches of *Quercus infectoria*, Oliv., formed by the puncture of gall-flies (*Cynips gallæ tinctoria*), belonging to the *Hymenoptera*, for the purpose of depositing their eggs. As the latter develop, excrescences called galls or gall-nuts are formed on the punctured places by the exudation of sap and enlargement of the cells. The larvæ which are inclosed in the galls are supported by the juices of the plant until they become perfect insects, when they perforate the gall and escape. When this happens the excrescence loses much of its astringent prfnciple and becomes lighter in color and finally entirely white, while if collected before the entombed insect is completely developed, the galls are of a dark to blackish color, and much richer in tannin.

The latter are known in commerce as *green galls*, and come from Aleppo, Smyrna and Mesopotamia.

Gall-nuts are also imported from *Cypria*, *Karamania*, etc., though they are not so good as the Aleppo galls, with which they are sometimes mixed.

European galls, formed by the puncture of other species of gall-flies on other varieties of oaks, are not so good as the

Aleppo galls. They come from the Morea, Italy, Hungary and Istria. Gallotannic acid is, as previously mentioned, the most accurately known.

Galls (Knoppern) formed by the puncture of a gall-fly (*Cynips quercus calycis*) in the young fruits of *Quercus pedunculata*. They are principally collected in Hungary, Dalmatia and Slavonia, and contain, besides a small quantity of gallic acid, much tannin closely resembling gallotannic acid. The percentage of tannin amounts, according to Mueller, to as much as 50 per cent.

Chinese Gall-nuts form irregular roundish bulbs of the size of a hazel or walnut, which inclose the insect. Their rind is smooth and felt-like, of a gray or reddish color, and very thin, and consequently fragile. They show no vegetable structure, but a dense, brilliant, resinous fracture, and are said to be derived from a species of sumach. They are much in demand on account of their high percentage of tannin, which, according to Mueller, amounts to as high as 65.5 per cent.

Rove.—The article known by this name, which is brought into commerce ground and pressed in bricks, is the so-called *Bassora* gall-nut, and is found in Persia and Asia Minor. It is principally exported by way of Smyrna. It contains about 27 per cent. of tannic acid. Mixed with oak or fir bark, it is, according to Eitner, well adapted for tanning sole leather.

Sumach consists of comminuted leaves, stems of blossoms, and branches of several *Rhus* species, such as *Rhus coriaria*, *R. cotinus*, *R. glabrum*, *R. canadense*, *R. typhinum*, *R. pentaphyllum*, *Arbutus uva ursi*, *Cyriaria myrtifolia*.

The following varieties are found in commerce:

Sicilian Sumach, from *Rhus coriaria*, is the most valued. It is divided into two qualities, the best being of a greenish-yellow color, while the inferior variety is of a more rusty-yellowish color, and has less smell and less tannic acid.

Italian Sumach, which is also derived from *Rhus coriaria*, is a dirty-green powder. It is far inferior in tanning capacity to the Sicilian variety, it being besides frequently adulterated with *sondro* leaves.

Spanish Sumach.—Three varieties of this occur in commerce, viz: *Malaya* or *Priego*, *Malino*, and *Valladolid*, the last two being of less value than the first.

Tyrol Sumach, the odor of which resembles that of oak bark, is derived from the leaves and stems of *Rhus cotinus*. Like the *Italian* and *Sicilian* sumach, it is frequently adulterated with fig leaves.

French Sumach (from *Coriaria myrtifolia*).

There are four varieties: *Fauvis*, *Redoul*, *Donzére*, and *Pudis* sumach, the last two being less liked than the others.

The "*Tezera*" sumach, used by the Arabs for tanning morocco leather, is derived from *Rhus pentaphyllum*.

American sumach is derived from *Rhus canadense* and *R. glabrum*. Large quantities of it were formerly used in the United States, the morocco manufacturers mixing it with an equal quantity of Sicilian sumach to form the tanning liquor, which was forced through the goat skins by hydrostatic pressure. Sumach is also used in tanning patent, enameled, and furniture leathers, sheepskins and grain, split and buffed leathers.

Swedish Sumach is prepared from the leaves of the bear-berry (*Arbutus uva-ursi*).

It is not yet definitely determined whether all the different varieties of sumach contain the same or different kinds of tannic acid, although the latter is most probable.

The tannic acid contained in the *Sicilian* sumach is, according to Stenhouse,* identical with gallotannic acid. In old sumach, the larger portion of the tannic acid has been converted into gallic acid and sugar.

Leather prepared with sumach possesses but little capacity for resisting water, and is therefore principally used for book-binding, portfolios, pocket-books, linings, bindings, skivers, etc.

Chrome tannage has however driven sumac almost entirely out of the morocco trade.

Valonia is the acorn-cup of *Quercus ægilops*, the prickly-cupped oak, a tree growing in abundance in the islands of the

*Dingl. Polyt. Journ. clxv. 150.

Grecian Archipelago. The tannic acid of valonia is not known in a pure state, as it always contains gallic acid. The use of valonia has recently much increased in Europe, it being especially employed, mixed with oak tan, for sole-leather in the last two spreadings of the hides in the binders. Leather prepared with valonia, is said to be harder and less permeable to water than that made with oak bark, its weight being also increased. The price of valonia which contains a considerable percentage of tannic acid, is low compared with that of tan, and it is much used by English tanners.

Divi-divi consists of the dried pods of a bush (*Cæsalpinia coriaria*) indigenous to South America. Leather tanned with the extract becomes very soft and spongy, and on exposure to the air assumes a more or less brown to brown-red color. The extract of the divi-divi pods is also brought into commerce. The tannic acid differs from the gallotanic acid, and, when heated, does not yield, like the latter, pyrogallic acid.

Myrobalans, the dried fruit of *Terminalia chebula*, is principally collected in India. The fruits exported by way of Calcutta are of a roundish shape, gray-black color, and hard and astringent. They contain, principally in the husk, a considerable quantity of gallic acid, which, according to Stenhouse, differs so far from gallotanic acid as not to yield, on boiling with dilute sulphuric acid, gallic acid, but a reddish-brown substance insoluble in spirit of wine.

Myrobalans are used in Europe in tanning as an addition to oak bark.

Bublah is the husk of the fruit of *Acacia bambula*. It comes from India, and contains considerable tannic acid.

Of the other foreign materials containing tannic acid, which, on account of their high price, etc., are more extensively used in dyeing and coloring than tanning, we will mention:—

Logwood, which is derived from *Hæmatoxylon campeachianum*, a *Cæsalpina* growing wild in Yucatan and some of the West Indies.

Fustic, obtained from *Morus tinctoria*. It contains a peculiar

tannic acid, moritannic acid, or macherin, which on heating yields pyrocatechin. It is only used for coloring leather.

Weld (*Reseda luteola*) is a plant belonging to the *Resedaceæ*, which grows wild in all European countries, though it is occasionally cultivated in Southern France and in Germany.

The following barks are also made use of in tanning, although not so extensively as hemlock and oak barks: —

Larch bark (*Larix Europæa*).—This bark yields a material relatively poor in tannin. It contains, according to Davy, 1.6 to 2 per cent. of tannic acid. The bark is used in England and Ireland for tanning sheep-skins.

Fir bark (*Pinus abies*) is principally used in Europe, in Austrian, Bavarian, Hanoverian, and Upper Swabian tanneries. It is claimed to be especially adapted for "plumping," or the so-called preparatory swelling and tanning of hides.

Hemlock bark is obtained from *Abies Canadensis*.

The bark is light, has a somewhat balsamic odor, and a slightly astringent taste. The tannin is colored green by ferric salts, and brown by potash lye. It is the most important tanning material of America, where it is much used for tanning both sole and upper leathers, two-thirds of all sole and upper leathers produced in the United States being tanned with it. This variety of leather has only lately been appreciated in many portions of Europe, and our exports of it are constantly increasing. A mixture of hemlock bark and oak, termed "union tannage," gives a very serviceable leather.

An extract of hemlock bark goes into the European markets under the name of *American hemlock extract*, and it is also employed in portions of this country where bark is scarce.

It is chiefly prepared from thick bark, since the greatest yield of tannin is, according to Eitner, obtained from the rind, and not from the pulp, an analysis of the latter showing 7.7 per cent. of tannic acid, and of the former 11.3 per cent., while the entire bark yielded 10.1 per cent.

Oak bark, from *Quercus monticola* of Michaux, rock chestnut oak, and *Q. tinctoria*, the yellow-barked oak, are the most highly

esteemed for tanning purposes in the United States. The best is the first-named variety, and the prime quality is derived from the Blue Ridge, which is the most easterly ridge of the Allegheny Mountains. The principal tanneries using rock chestnut-oak bark are located in the state of Virginia, the western portions of the Carolinas, and in Tennessee; the bark in the latter state being derived from the Cumberland Mountains. In tanning it is used unmixed, and gives a beautiful "bloom;" the sole leather produced with it being always in demand for both home consumption and for export. The oak tan bark of Mendocino county, California and of the upper coast of that state is probably the finest in the world for tanning purposes. The bark of the yellow-barked oak is in tanning commonly mixed with red-oak bark, as the color which the former yields when used alone is objectionable.

The inner bark of the *Q. tinctoria* is the *quercitron* of dyers. The barks of the *Q. alba*, white oak, and *Q. rubra*, red oak, are not esteemed in tanning, the first being poor in tannin and the second imparting an undesirable color to the leather.

Canaigre.—In the rainless regions of the southwest, the Aztecs, Zuñis, Pueblos, and later on the Mexicans, have for centuries been tanning hides with the root of a sour dock or wild rhubarb, *Rumex hymenosepalus*, called by the early missionaries sour cane, "Cana agria," which was finally pronounced cah-nager, and spelled canaigre.

The commercial value of canaigre depends upon its tannic acid. This is found in all parts of the plant, its leaves, seeds and flower stalks, but mainly in its roots, of which it forms an average of about nine per cent. in the green state. Of importance also in tanning are certain red and yellow coloring matters which are extracted along with the tannic acid, and which affect the quality of canaigre-tanned leather. As much as three per cent, of starch is also found. This is an undesirable constituent, causing trouble in the tanneries unless it is removed by a suitable process of extraction. The roots contain an average of about 70 per cent. of water, more or less, according to the age of the plant and the abundance of water supply.

The amount of tannic acid varies much with conditions of growth. Adverse environment seems to be associated with the largest percentage, while well-irrigated roots, grown in rich soil, show a distinct decrease. The lighter color of cultivated roots, however, is said to be preferred by tanners. During the annual period of growth the tannins seem to increase most rapidly at the beginning of summer, when the plant is dying back to the ground. It appears that at this time the astringent sap of the leaves retreats into the roots, contributing materially to their percentage of tannic acid.

Professor Forbes says:

"As regards the value of canaigre tanning materials, the earlier favorable opinions of tanning chemists have been excellently supported by the experience of the trade. From various sources it is learned that canaigre chips and extracts have been successfully employed either alone or in connection with other tanning materials for the production of a remarkable variety of leathers, including both heavier and lighter grades. According to the statement of different tanners, it is employed in the production of:

"1. Patent and enameled leather for the carriage, saddlery and upholstery trades.

"2. Patent and enameled leather for fine shoes.

"3. Carriage covers and dashboard leather.

"4. High grade of carriage and furniture leather and a fair grade of patent shoe tipping.

"5. Upper, grain, or similar light leather.

"6. East India kips finished as waxed leather.

"7. Yellow for mittens, horse hides, butts, kangaroo, glazed kid, and other fine shoe leather.

"8. The heaviest sole and harness leather, and the lightest calf and sheep, with best results for all kinds."

Quebracho is a Spanish word meaning axe-breaker, from the toughness of the tree, which breaks the sharpest axes. It is a tree which grows only in Gran Chaco in the Argentine Republic. Two species are known, the *Quebracho blanco*, which is only

used for building purposes, and *Quebracho colorado*, or red wood. It varies in color from gray to dark, which depends entirely upon the tanning and coloring matter which it contains.

The material is too strong in tannin, possessing insufficient non-tanning proprieties to yield well-nourished leather unless combined with agents which are stronger in non-tanning substances.

The discovery of the valuable tanning properties of this wood is due to Mr. George Fahr of Pirmasens in Bavaria, who on a visit to the Paris Exposition of 1867 saw quebracho wood from Gran Chaco exhibited as a dye-wood. He had it analyzed in Vienna and found that it contained 22 per cent. of tannin and 8 per cent. of coloring matter. This led him to import some of the wood. Later analyses were equally favorable, and in 1871 several firms in Havre and Antwerp imported considerable quantities of the wood. Mr. Fahr and his brothers then got up machinery to rasp the wood, and by 1876 were enabled to furnish considerable quantities of quebracho chips to Alsatian, Rhenish and Swiss tanners. But through the improved tannage obtained by using quebracho wood Messrs. Fahr found their leather in such demand that they were compelled to give up the supplying of quebracho wood to other tanners, as they used all they could produce in their own tannery. Tanneries in Argentina also kept pace in tanning with quebracho, and the primitive tanneries of that country soon grew into enormous establishments. As their hides and tanning material were at hand and cheap, they quickly obtained European markets for their leather, which markets were needed to prevent overproduction in a country that only offered poor markets for them. The leather made with quebracho is superior both in firmness and color.

The quebracho tree of Gran Chaco is about 18 to 36 feet in height and has a diameter of 18 to 40 inches. When first felled the color is a light yellow but on exposure it turns to a light red.

The best wood comes from Vera, three days journey from Buenos Ayres on the railroad leading from Santa Fé to Garabato, where virgin forests are found along the Parana and the Picole-

majo rivers. It is said that when quebracho wood is of good quality and freshly rasped it retains much natural moisture so that it will ball up in the hand. This moisture is said to be due to the quantity of tannin it contains, and which when first felled oozes from the cut surface like resin.

At a convention of German tanners held in Hamburg, Professor Eitner in his speech made some interesting remarks on the uses of quebracho.

The speaker said that the advantages of the quebracho wood consisted not only in making the tanning cheaper on account of the low price of the material and the obtaining of a larger output, but also on account of effecting rapidly a thorough tanning especially for certain kinds of leather; and a splendid product can be obtained by the addition of quebracho wood to the liquor.

"All tanning matter," said the speaker, "contains, if I may so express myself, three different kinds of tanning material, to wit., one pale and readily soluble, which penetrates the hide very easily and impregnates the fibre itself; a darker one a little less soluble, which also enters the hide easily and is fixed to the exterior part of the fibre; and one almost insoluble, which only enters the hide by violent means and which makes the leather dark colored and of a disagreeable appearance.

"Now, it is in the wood of quebracho that the first of these tanning substances is found in large quantities, and explains the fact that the pale liquor of quebracho wood penetrates so easily into the hide, more readily even than sumach. And it is this quality that renders quebracho particularly valuable to the tanner.

"If the quebracho is not qualified to furnish a solid leather in the ordinary process of tanning—if the leather tanned with this substance fails in some qualities—it is on the contrary particularly adapted to tan the hide promptly and thoroughly, and to render it proper for the absorption of strong liquor, that is to say, the thickest."

To obtain a solid and completely saturated leather the speaker recommends a mixture of quebracho and oak bark as

being practically efficient. "Oak bark," said he, in substance, "is not the enemy of quebracho wood; as the two tanning substances can be used together. By adding to the oak bark some quebracho wood the expense of the tanning is decreased and leather is obtained which in quality and appearance is the equal of that tanned with pure oak liquor. Good results may also be had by mixing other kinds of tannin with the quebracho, which is of benefit to the small tanner."

A sample of leather tanned with quebracho extract will be found with the other samples at the end of this book. It is furnished by A. Klipstein & Co., who are the pioneers in quebracho in this country and the chief importers, handling as they do the output of the principal factories of the world furnished for American consumption.

Quebracho is especially interesting because of its adding weight and firmness to leather, and also because it furnishes light leather, which is excellently well adapted for the taking of all sorts of dyes; and heavy leathers of all kinds of excellent quality.

A. Klipstein & Co.'s head office is in New York, and their branch offices are in Philadelphia, Boston, Chicago, Providence, Cincinnati, and Hamilton, Ont., where stock is carried and full information furnished as desired.

A. Klipstein & Co. have issued a little pamphlet descriptive of the qualities and use of quebracho. It is interesting as showing the extent of the sale of this tanning material and its utility for the purpose intended. They give the analysis of the quebracho from a tract of land at Gran Chaco, as follows:

Tannic acid	28.20
Foreign substances	1.70
Extract ashes	0.40
Water	11.85
Insoluble parts	57.85
	100.00

For some years past quebracho has been employed in every

European tannery with success, and the following figures will show that within the last four years the exports from the Argentine Republic to Europe have rapidly increased, as follows:

1892	29,700 tons.
1893	49,400 "
1894	54,540 "
1895	154,000 "

Of all European countries, Germany has become the largest consumer, having used it chiefly for sole leather. The result has been the almost total destruction of the American export trade in sole leather to Germany, as may be seen from the U. S. Treasury reports as follows:

SOLE LEATHER EXPORTED TO GERMANY FROM THE UNITED STATES FROM 1876 TO 1896.

	Pounds.		Pounds.
1876	6,400,000	1887	1,900,000
1877	6,100,000	1888	1,800,000
1878	7,100,000	1889	1,600,000
1879	7,500,000	1890	1,700,000
1880	3,900,000	1891	1,400,000
1881	3,600,000	1892	816,000
1882	2,500,000	1893	548,000
1883	2,400,000	1894	542,000
1884	2,500,000	1895	733,000
1885	3,000,000	1896*	186,000
1886	2,000,000		

* For 10 months.

The quebracho tree grows in the large forests known as Gran Chaco, situated in the northern part of the Argentine Republic. The logs, which are employed for tanning purposes only, are used without the bark and run from 5 to 10 meters in length with a diameter of from 50 to 100 centimeters. The best wood grows north of Vera Station on the railway line from Santa Fé to the Gran Chaco (Garabato). These forests extend in the north as far as the river Bermejo, and in the east as far as the river Parana.

There are also some small forests situated on the opposite

shore of the river Parana, in the Province of Corrientes, and some in the west as far as the Provinces of Salta and Santiago del Estero.

The soil of the surrounding provinces is unfit for the growth of quebracho, and the trees found in the districts of Corrientes (Empedrado) and Satiago del Estero, are small and poor, which accounts for the bad quality of the quebracho coming from these provinces, while the Gran Chaco product, on the contrary shows far stronger tanning proprieties combined with a lighter color. Tanners will understand the importance of always using the better quality of quebracho when they know that the inferior and cheaper kind, besides containing far less tannic acid, is also full of a peculiar dye-stuff which gives the leather a dirty color and decreases its weight, while pure Gran Chaco wood gives the leather a clear light yellow tint, and considerably increases its weight.

Thê advantage in the use of quebracho lies in the fact that the tanning process is rendered much cheaper, owing to the low price of the tanning material and the better results obtained. Besides, the process is more rapid and the tanner is enabled to obtain by it good leather of various kinds.

The best results are obtained by mixing quebracho with other tanning materials, and the German tanners have successfully employed a mixture of quebracho and oak or fir bark.

Different tanning materials, such as hemlock, gambier, canaigre, oak or fir mixed with quebracho, give the very best results, and the use of quebracho considerably reduces the expense of tanning sole and upper leather.

Those who have carefully tested quebracho are now steady consumers of it, and are fully satisfied as to its good properties.

The following process is given for using pure quebracho wood for sole leather in Buenos Ayres, taking as an illustration 30 cow hides:

First or coloring liquor.—The hides are first treated with some partially exhausted liquor 4 to 6 degrees in strength. If there is no such liquor employ clear water with quebracho of

the strength above mentioned, then handle about four times until an even color is obtained. Much attention should be given to the first liquor so that the leather receive a light color. Should the liquor be cloudy use a little alum-water to clear.

Second Liquor.—For 30 cow hides put 180 kilos. quebracho chips in vat with fresh water and handle the hides several times for a couple of days. Take out the used wood and put in some 180 kilos. more, then handle twice a day until all the tannin is extracted from the wood, probably in about four days.

Third Liquor.—Put 200 kilos. quebracho in vat with fresh water, handle the hides in this once a day for six to eight days, when they will be ready for laying away.

At the laying away hides receive about 26 kilos. quebracho per hide on the grain side. When the vat is filled add the liquor from the spent wood out of former steeping and let the hides rest 25 to 30 days. After this take the leather out of the vat, rinse it well in previously used liquor, and let it run dry without liquor or water in the washwheel.

About half an hour will suffice to make the leather pliable. To work it on the table give it a good washing with water and sulphuric acid, then dry and roll the leather carefully.

Hides worked in this way show a bright clear yellow color and good weight, and are quickly tanned.

Method for employing quebracho with oak bark for sole leather in Europe, as recommended by Mr. Eitner at the Tanners' Convention in Hamburg:—

In the manufacture of heavy sole leather, which presents the greatest resistance to the absorption of the liquor, the following method is recommended for an ordinary pack:

During the swelling it is not only important that the acid of the liquor should preponderate, but also that it should be pure and free from all injurious fermenting substances. The hides should be left in soak 24 to 28 hours—then rinsed and replaced so as to be in proper condition for the liquor. While in the first and second liquor they are treated to a mixture of 7½ kilos. of quebracho and an equal quantity of oak bark; if a third

liquor is necessary use a mixture of 60 parts of quebracho to 40 parts of oak bark, and leave them in the liquor for about 20 days. By this repeated and prolonged immersion the time employed for tanning is considerably shortened.

At the first laying away the hides will receive 20 kilos. of powdered matter, consisting of 60 parts quebracho to 40 of oak bark; on the second laying away a larger proportion of quebracho may be employed. Time of immersion about the same—about 20 days.

The washing is done with the spent liquor obtained from the previous operations.

The feature in the sole leather situation in the United States since the bank-panic of 1893 has been the growing call for cheap stock, this being true not only in regard to sole leather, but consumers seem to demand cheapness in nearly all kinds of leather. This must tend to an increase in the consumption of tropical tanning materials used in connection with the old fashioned bark liquors. The growing importation of foreign tanning material has had the effect of considerably cheapening domestic oak bark. Oak-tanned leather can be produced at less cost to-day than ever before.

However, even where oak bark is used, the desired results, *i. e.*, cheapness and rapidity, can only be attained with concentrated liquors, and soon, no doubt, a tannery not furnished with an extract plant and not using extracts such as are to be had in the market, to strengthen and also to cheapen the liquors, will be the exception.

Whether the production of quebracho-tanned sole leather will continue to increase at the present rate in Germany is a question hard to answer. The enlargement of the tanneries making this class of leather now in operation, and the number of new yards, either completed or in course of construction, are meanwhile amply sufficient to supply the present demand.

The United States has lost its export trade in sole leather to Germany through the introduction of quebracho-tanning in that country, and probably other loss of trade with other countries will follow from similar causes.

The importance to the leather producer of keeping himself fully posted on what is going on around him, can hardly be over-estimated. It is if possible even more essential that he should do so, than is the necessity of giving the closest attention to the department of his business involving the purchase of raw material and sale of the finished product.

Quebracho is cheaper than oak bark and costs but little more than hemlock. Quebracho, however, is claimed to lack some of the important non-tanning constituents of other tanning materials which "nourish" the leather and serve to acidify the tan-liquors while effecting no actual change on the organic tissue of the leather. It should therefore be used only in conjunction with other tanning materials, richer in non-tanning matter. The red quebracho contains a large proportion of red coloring matter, easily soluble in warm water, although vigorously resisting the action of cold. Consequently, proper precautions must be observed, or the leather will have a reddish tinge. Leather tanned with quebracho alone has no specially distinctive color. If alum and salt are added, finer results even are attained than with gambier. Quebracho, alum and salt produce a handsome pale straw-colored grain, leaving the flesh-side almost white. Several large establishments in Germany are devoted to the manufacture of quebracho extract, notably two in the vicinity of Hamburg, and one near Frankfort. The extract is put up in crystallized form, containing 65 to 70 per cent. tannin, or as a soft paste containing about 45 per cent.

Palmetto root.—Palmetto root is found abundantly in Florida, and also grows in Alabama and Louisiana. There is some in Tennessee. It shows 10 per cent. of tannin. The root can be cut up like bark. The tannin produces tough grain, and strong durable leather. Its action is rapid. Palmetto has long been studied in regard to tanning. It tans rapidly, giving pleasing light color, toughness and pliability, and is a good filler of leather.

It has attracted much attention of late years in the south, a tannery using this material having been in operation at

Sanford, Fla., for some time. Palmetto is a comparatively new material to leather manufacturers. Its merits will no doubt be fairly tested particularly when offered for sale in the convenient form of extract.

Chestnut oak wood is also for tanning; it is prepared in the form of an extract and is fully described in Chapter V.

Walnut bark from *Juglans regia* gives a very soft leather, but can only be otained in small quantities,

Lombardy poplar bark gives a light-brown leather with an odor resembling that of Russia leather.

Elm bark from *Ulmus campestris*, is especially used in Norway for manufacturing the beautiful Norwegian glove leather.

Horse-chestnut bark, from *Æsculus hippocastanum*. The bark of this tree contains a tannin which is colored intensely green by ferric oxide. Besides the tannin, which is also found in other parts of the tree, the bark contains fraxin, fraxetin, æsculin, æsculetin, and æsculetin hydrate, a small quantity of a peculiarly yellow crystalline body and a pectine substance which is decomposed into formic acid, oxalic acid, and protocatechuic acid by boiling potash. The leaves of the horse chestnut* contain also tannic acid, wax, a variety of resin ($C_{26}H_{22}O_n$) and a resinous substance ($C_{17}H_{28}O_7$) possessing a peculiar odor of frankincense. The young leaves and buds contain a peculiar tannin to which Rochleder has applied the term "*phyllocitannic acid.*"

Æsculotannic Acid.†—Different kinds of tannic acid are found in the horse-chestnut, æsculotannic acid ($C_{26}H_{24}O_{12}$) occurring, according to Rochleder, in the bark, leaves, flower-buds, ripe and unripe seeds, roots, and the trunk. In a pure state it forms an almost colorless amorphous powder readily soluble in water, spirit of wine and ether. By the action of the air and an alkali, or substances containing oxygen, such as chromic acid, it is decomposed into a brown body having the constitution $C_{26}H_{22}O_{13}$. Fusing with potash changes æsculotannic acid into phloroglucin and proto-catechuic acid. Ferric chloride colors the tannic acid green.

* Rochleder Wiener Akadem., 24 to 48; 236 to 254; 604; 607 to 657.

† Ibid., liv. 607.

An aqueous extract of the bark comes into commerce under the name of "*horse-chestnut extract.*" The percentage of tannic acid in the extract varies according to its specific gravity. It is at present much used in Germany and other portions of Europe as an addition in oak-bark tanning, and is said to give good leather. It is considerably cheaper than quercotannic acid.

Willow Bark.—The following are the principal willow barks used in tanning; *Salix alba*, *S. arenaria*, *S. fragilis*, *S. purpurea*, etc. There is not much difference in the value of the barks, though it is claimed that barks containing salicin, as for instance that of *S. purpurea*, are not so good as others. The amount of tannin varies from 6 to 16 per cent. In Russia willow bark is used for tanning Russia leather, and in Sweden and Norway for preparing the well-known Swedish glove leather. The tannic acid contained in willow bark colors ferric salts green, and, when treated with dilute sulphuric acid, yields sugar and possibly gallic acid, though this is doubtful.

Alder Bark contains a high percentage of tannin, amounting, according to Gassincourt, to 36 per cent.

Beech bark from *Fagus silvatica* mixed with oak bark may be used as a substitute for the latter, but the resulting product is of an inferior quality. It contains according to Davy, 2 per cent. of tannin, and besides a peculiarly red matter and a substance with an odor of vanilla.

Protaceæ Barks.—The trees from which this tanning material is obtained are indigenous to the Cape and Australia. The principal ones are the *Protea canocarpa* (knotted tree) and *Banksia serrata*. The tannin of the latter imparts a beautiful violet-blue color to solutions of ferric salts, while that of the first colors iron green. Both give a brown color with potash lye.

Snouba Bark.—The *Aleppo* fir (*Pinus halepensis*) yields two important tanning matarials, namely the *snouba* bark, and the *scorza rosa*. The first is the inner bark of the tree freed entirely from the rind, and comes from Tunis and Algiers.

The *scorza rosa* is the rind of the same tree, obtained in Southern Italy, and especially in Sicily, from the living trees in

a very rational manner, so that the flesh of the bark remains intact, and produces, like the cork tree, new bark, which is periodically taken off. *Snouba* bark contains 25 per cent. of tannin, and *scorza rosa* 13 to 15 per cent. The tannin colors ferric salts green, while it becomes brown by an addition of potash lye.

Ratanhy root is obtained from *Krameria triandra*, which grows in Peru. The root comes into commerce in a comminuted state, and is very rich in tannin, which is extracted with water, and the resulting solution used as an addition in tanning. The proportion of tannin is, according to Peschir, as much as 42.6 per cent. It corresponds, according to A. Rabe,* with the formula $C_{20}H_{20}O_9$. It is not a glucoside, and passes, by the splitting off of H_2O, over into *ratanhy red* $C_{20}H_{18}O_8$.

Avens root, from *Geum urbanum*, contains, according to Trommsdorff, up to 41 per cent. of tannin. Solutions of it have occasionally been used as an addition in tanning.

Tormentil root and *Sassafras root* show a still higher percentage of tannin, the first containing, according to Gassincourt, 46 per cent. of it, and, according to Reinsch, up to 58 per cent. Both roots being very expensive are not often used for tanning.

Geranium wallichianum is a new tanning material which grows in India and contains about 25 per cent. tannin. Leather tanned with it greatly resembles that tanned with canaigre, it being only somewhat darker.

The wood of the *Algarobia glandulosa* of Gray, *mesquite oak*, and *Quercus virens*, *live oak*, contains much tannin in its entire mass, and is very successfully used in America in place of tan.

Mimosa.—Besides the foregoing, the following tannins have been proposed and occasionally used: Barks of *Butea frontosa* and *Butea gibsonis*, both indigenous to the West Indies; fruits of *Balsomokarpon brevifolium*†, bark of *Eucalyptus; Pangue*, a root growing in India; *Pimica granatum*, etc.

In Chapters XII and XIII, we shall discuss the mineral tanning substances.

* Pharm. Zeitung f. Russland, xix. 577.

† Engl. Patentberichte, 1875, Ramsbacher, Masurer.

CHAPTER IV.

LEACHING; THE BARKOMETER; BARK MILLS; BARK CONVEYER; THE TAN PRESS.

THE present generation need fear no scarcity of hemlock or oak bark. The question of the day, in the struggle for economical results in the tanning industry, is leaching. Many tanners delude themselves with the idea that they are getting the best results possible considering the conditions under which they are working, and by an occasional analysis of their spent tan they apparently prove their position.

The results to be obtained must be admitted to consist in the extraction of a maximum amount of tannin with a minimum amount of water. It therefore does not follow that when the exhausted bark shows only one per cent of tannin, which is considered a good result, that the tannin taken out has been secured economically.

There are at least four cardinal points to be considered in leaching, viz; 1st, the character of the material to be treated; 2d, a proper division to secure the best results; 3d, the temperature and quantity of water; and 4th, the proper handling of the liquor. In addition to these are the minor questions of the shape and size of the leach, the handling and wetting of the bark, forced or gravity leaching and many other points.

Many elaborate and expensive systems of forced leaching have been tried, and fairly good results have been obtained by these methods—upward flow and downward flow, and all the other modifications that impractical ingenuity could devise.

The more elaborate and expensive the system and the more patents and secrecy surrounding it, the better the results have been supposed to be.

It may be assumed that a system best for oak bark might not be the best one for hemlock or canaigre. Yet there are certain general principles applicable to all which may be modified to suit the material to be treated, and the results are largely dependent on the skill and reasoning faculty of the operator.

As a rule only one general system is employed by American tanners and extract makers and that is the gravity system. To advocate any other system, such as modifications of the diffusion process, involving the expenditure of large sums to violate the laws of nature, would necessitate the rebuilding of 99 per cent. of the leach houses in America; therefore, attention will be paid to securing the best results under the system generally employed, involving as few changes in arrangement as possible.

A man must fully understand what he has to do before he can determine the best way to do it. In the case of leaching we will assume an extreme condition to make the subject plainer. Suppose the bark, instead of being prepared in the usual way, is cut in pieces one inch thick and two inches square. It will be readily seen that if cold water is pumped on top and at the same time removed from the bottom, passing rapidly among and not through the pieces of bark, an immense quantity of water will be handled and yet the bark will practically never be exhausted. This is an extreme illustration of the most common way of leaching.

What we must do is to pass the water through the bark and not around it. We must regulate the temperature so as to secure the greatest solvency, therefore we grind or cut the bark and warm the water. Still, no matter how fine the bark or how hot the water, if the operation is rapid the solvent passes around the particles of bark and not through them; therefore, slow leaching is absolutly necessary to secure maximum density in the liquor.

If we have a leach filled with dry bark and water, or weak liquor is pumped on it, it at once goes to the bottom and does not dissolve or take up the tannin in the bark above it. This is another method of forcing the liquor around the bark instead

of through it; therefore, a leach when once filled with liquor should never be allowed to become dry or out of the liquor on top. There is a loss to be incurred in extreme slow leaching. The point of saturation must not be overlooked. A gallon of water at 60° Fah. will hold in solution a definite quantity of tannin, sugar, salt, or other soluble matter and no more. At a higher temperature its solvent power is generally increased, but on cooling again the excess is thrown out of solution. Tannin and the other soluble principles of bark are heavier than water as shown by the *barkometer* or *hydrometer*.

If we fill a leach with fresh bark properly prepared and then let in warm water and allow it to stand undisturbed for forty-eight hours—although at the beginning the conditions throughout the leach were uniform—we will find after this maceration, or soaking, that both the liquor and chips at the bottom of the leach are stronger than the liquor and chips at the top of the same leach. This result has been secured without a particle of expenditure of power or labor. If we remove slowly the liquor at the bottom, we gradually let the weak liquor at the top down on the strong chips below, and the top liquor should in turn be replaced with a liquor weaker than the bark to be treated. In this case we allow the solvent to pass through the bark and not around it, it becomes saturated with soluble matter, and no power or labor is expended until all has been accomplished that is possible.

Therefore, this general rule may be laid down—for the head leach—no liquor should be removed from the bottom until it reaches the practical point of density and only so fast as it reaches this point. This may seem very slow work, but the point to be gained is not the securing of a large amount of weak liquor so much as a large amount of tannin. If we can get that tannin in the shape of liquor weighing 40° Twaddle, it is better and cheaper than to get four times the quantity of 10-degree liquor.

The ideal leach should never be idle or dormant, nor should it be allowed to flow so rapidly as to be, figuratively speaking,

"beating the air," or accomplishing results out of proportion to the power and labor expended. It should always be full of liquor in motion, until exhausted and ready to be pitched. The liquor in a leach should always be weaker than the bark to be treated.

In a series of twelve leaches, we would start at No. 1, supposing all to be filled with fresh bark. Fill No. 1 with weak liquor or water, allow to soak a few hours and pump from the bottom of 1 to the top of 2. As fast as the liquor reaches the practical point of saturation, remove to the storage tank for future use in the vats or pans, and pump the balance to the succeeding leach, and so on.

As the leaches are always full of liquor the pump lifts only a few feet and uses very little power. This is practically the Holbrook system, which is however defective, in that the pump in each leach is operated by a common rod and all run at the same speed, owing to the fact that in a series of leaches no two are in the same condition. The speed of each pump should be regulated separately, which can probably be best done with an air-lift pump regulated by a valve. Jet pumps are objectionable because they reduce the strength of the liquor by condensation of steam and they will not handle hot liquors.

In this way we have always a stream of liquor flowing on the top of each leach and a stream of stronger liquor from the bottom of the same to the succeeding stronger leach. From the head leach we have from the bottom a constant stream of saturated liquor and on the tail leach a constant stream of boiling, or hot water. We secure a maximum of tannin with a minimum of solvent, economy in hot water, labor and power.

The most seriously defective and yet one of the most common systems of leaching is found in houses having only one large pump, connected by water logs with the bottom of each leach. A wonderful show of work appears, but every accepted principle of leaching is violated—the liquors are all lifted the full height of the leach and from six to ten feet higher, they are jerked through the bark so rapidly as to make the use

of enormous quantities necessary, strong liquor is forced over weak bark and gravity lost never to be recovered, fully double the boiler capacity is required and the final or finished liquor is not over one-third the strength that it should be. To pump the liquor from the bottom of any leach to the top of the same leach always involves a loss of power, labor and tannin—the bark should always be stronger than the liquor. It is more desirable to use one gallon of water to exhaust a given quantity of bark than to use ten, as well as very much cheaper.

The Vaughn Machine Company, Peabody, Mass., now make leach pumps especially designed to do economical work.

The latest mode of quick tanning uses borax to thoroughly cleanse the hide or skin of all impurities, thus making the texture very open and receptive to the tannin, and then by using borax in the water employed for leaching, causes a very gentle fermentation of the bark, either oak or hemlock, so as fully to extract the tannin and allow it to enter into combination with the hide or skin without becoming in any degree crystallized.

For grain, split buffed, patent, enameled, furniture, in fact any leather which requires a smooth split, there is no agent so good as borax, which can be used in the soaks and in the water employed for leaching the bark. The borax is used in the proportion of five pounds to the one thousand gallons of water, or a little more borax can be used if the water is very hard.

The borax is first dissolved in boiling water and then added to the water under vigorous stirring.

There is no patent on this system of leaching which we have advocated in this chapter, and it can be adopted in any leach house with slight expense. The question of regulating the temperature of the liquors is one of no little importance, and is dependent on the material to be treated. The temperature in a general way should be increased as the liquors become weaker. After the proper temperature for the head leach has been determined, the next weaker should be hotter and the temperature increased in each succeeding weaker leach until the boiling point is reached in the tail leach. As a rule

very little heat is needed except for the tail leach, the liquor cooling as it goes forward and by the cooling of the liquor resins and other matter insoluble at low temperatures are thrown out of solution and are removed mechanically in passing through the bark. Under certain conditions, as in winter weather, when the liquors cool too rapidly it is convenient to have a steam coil of copper pipe in the bottom of each leach below the false bottom, so a little steam can be used if necessary to keep the liquor up to the proper temperature.

Extract manufacturers claim to secure larger yields of tannin from their bark than tanners, and doubtless in a general way they do, as their attention can be concentrated on this one point, but waste never profits any one and economical results benefit all.

The proper leaching of bark, although apparently a difficult problem, is really a simple one when once understood. Much of the difficulty experienced is brought about by the lack of proper checks and records when a new experiment is tried.

The difficulty does not end here, but is still further magnified by *erroneous conclusions*. For example, an experiment is tried and proper precautions are not observed in getting the data; so called insignificant matters are ignored, although the success of all experiments depends upon them, and at the end of the experiment we review such data as we have, and immediately conclude that this or that system is wrong or right, when in fact by taking into account so called insignificant matters the conclusion is just reversed.

It is a well known fact that a soluble body, or one enveloped in a body which is hardly soluble, will dissolve much more quickly in a fine state than if it were in a large piece or pieces. For instance, granulated sugar will dissolve much more rapidly in water than will rock candy, although both are identical and are only presented in different physical states. We have an analogous case in bark, large pieces of ground bark corresponding to the rock candy and finely ground bark to the granulated sugar. But it must be observed that water will dissolve just as much in

either case if given sufficient time; that is, the rate of solution is slower or more rapid, as the case may be. Water will penetrate to a certain depth in bark in a given time, and dissolve a certain amount of soluble matter. It will also take a definite time for this solution in the bark to diffuse into the surrounding water. It will be granted that the finer the bark the more rapidly will this diffusion take place. Knowing the above facts, it is evident that fine bark will leach more perfectly in a shorter space of time than coarse bark. It is well known to tanners that it is impossible to leach the bark, or to get any liquor through the mass of bark in the leach, when the bark is ground too finely, and when the old system of draining or pumping off is used.

This difficulty of packing may be overcome by always keeping the leach full of liquor, so as to keep the bark floating and allow the liquor to pass evenly through it. It is possible, however, when the leach has packed to force the liquor through the mass of bark with pressure, such as is used in the diffusion system. It even then happens that the leach or cell packs, and it is then necessary to reverse the pressure to partially loosen the mass and facilitate the circulation. But it is never possible to bring about the *proper* circulation when once the leach or cell has packed. But why should an unnecessary amount of complication and expense be added when it is possible to accomplish the same results in a much more simple manner? This can be done in the following way: The bark is comminuted as finely as possible; that is, it should be either cut, shaved or shredded, rather than ground to a dust. The bark so prepared is conveyed to the leach, which, when full, is properly levelled off and covered with boards, which, in turn, are held down with two heavy pieces of timber slipped under cleats fastened to the sides of the leach near the top. The bark, therefore, is held down when the leach is full of liquor. The leach is now filled with water or weak liquor and when full it can be pumped off at once, but it is preferable to allow it to stand over night.

The pumping is done from the bottom of the leach through

a copper or brass tube which extends to the top. This pumping is so regulated as to draw off just as much liquor as is run on the top, so as always to keep a sheet of liquor six to twelve inches deep on the top of the bark. This sheet of liquor plays an important part and really determines the success of the leaching, as the liquor follows directly, without channeling, and takes the place of the stronger liquor which has gone before it when the leaching is in progress. The result is that the great factor "percolation" is taken advantage of. The pumping is continued until the liquor is reduced to a point where it cannot be used in the tannery. The liquor is then pumped on to a fresh leach which is treated in the same manner as the first, which has just been described, and so on through the whole series of leaches. The number in a series should run from ten to twelve or more, depending upon the depth of each leach.

It is well known that the longer the column of bark through which the liquor passes the stronger is the liquor and more perfect the leaching. But there is a limit to the length of the column in any one leach, as when we exceed a certain depth, say ten or twelve feet, we interfere with the circulation, or, in other words, the bark packs and we experience the difficulty alluded to above. In order to get the benefit of the long column we take advantage of the number of leaches, as we can thereby increase the length of the column to any extent desired.

The advantage of ten or more leaches is apparent when the density of the liquor is taken as it comes from each pump. It will be found that the difference between the tail leach and the one next to the head will be from one to one and a half degrees for every leach. For example, suppose there are twelve leaches; the water leach will show one degree and the eleventh leach from eleven to sixteen degrees barkometer, and so on.

By observing the above precaution and following the method described, it is possible to make a stronger liquor of the same quantity than under the usual conditions. In other words, we get the same amount of tanning substance in a more concentrated form, or we will complete our leaching with less water.

Attention should be called to the fact that efficient leaching cannot be done with cold or merely warm water or liquor. It is necessary to apply the water or liquor on the tail leaches as hot as it can be made, say from 205° to 212° F., and to work the leaches actively.

It will be found that the liquor from the head leach, after it has been pumped down in density until it is ready to go onto a fresh leach, registers from 110° to 120° F. It is now advisable to pass it through a heater—especially during the winter months—before putting it on the fresh leach. The liquor should have such an initial temperature that it will register about 95° to 100° F. after having passed through the fresh bark.

It will be found that by working according to these temperatures, about 950 gallons of a 22° liquor, barkometer at 60° F., containing about 2.75 per cent. tanning substance, can be obtained from 2,000 pounds of bark, which means that we have extracted about 90 per cent. of the tanning substance of the bark. On the other hand, if the temperature of the liquor is 10 to 15 degrees lower, the quantity of liquor will be reduced from 20 to 25 per cent.

It will be found when the density of the liquor coming off the head or fresh leach is noted every five minutes—proper correction being made for the difference of temperature—that the density falls regularly.

If the figures so obtained be platted on paper—paper ruled in squares, called platting paper, such as engineers use,—it will be found that the fall in density follows a curve which is nearly a parabola, such as theory indicates.

The most convenient and accurate check on the efficiency of the leaching is the measuring and weighing, that is, taking the density of the liquor from each leach.

The liquor should occasionally be analyzed, to show whether the ratio of tanning substance to the degree of barkometer varies, and to what degree. Any variation should be allowed for in the calculation for the efficiency of leaching.

It might be said that just as efficient leaching can be done

when the bark is not cut or ground so fine, by giving longer time. Tanners will submit as a proof the analysis of the "spent bark" according to which there is more tanning substance in the coarse than in the fine spent bark, which has been leached in a much shorter space of time.

It is not known, however, that the difference between the fresh and spent bark (coarse) is in the liquors in an available form.

It will be found when the liquors from the coarse bark are measured—just as from the fine bark—that the quantity is considerably less. That is, the amount of tanning substance really in the liquors falls short, and the efficiency of leaching is not so great.

It may not be generally known that bark in the *lyaways* loses comparatively little of its tanning substance in two or three weeks while in the liquors. It cannot be said that the reason of this is that the liquor is as strong as the bark, because in putting just as strong or even a stronger liquor on a fresh leach we get a proportionally stronger liquor. So there is something else beside simply soaking. When a warm or hot liquor is put on a leach and left to stand, the temperature of the top liquor falls very rapidly.

When this cold liquor passes down through the bark it reduces the temperature, so that it is alternately heated and cooled, which is fatal to perfect leaching, as the temperature of bark and liquors should be steadily increased toward the tail or water leach. The only way to do this properly is to work the leaches actively. Leaches ought to run day and night.

Some tanners still advocate putting the spent liquor from "rockers" on the tail leach. The very small amount of tanning substance saved (such liquors do not contain at the utmost over one-half of one per cent. and usually from two-tenths to three-tenths per cent. of tanning substance) is completely overbalanced by the large amount of *filth*, non-tanning substance, etc., always present in such liquors.

What is the object of applying a mellow liquor, weak in tanning substance, to a green hide from the beam house? It is to

purge it of the *lime and filth*. If we are so anxious to get rid of these on the one hand, why should we take particular care to recover them, as it were, on the other?

The lime which is kept in solution by means of the organic acids present in the liquor, is partially precipitated in the bark as soon as the acid is absorbed by it. The consequence is that there is considerable tanning substance fixed which cannot be extracted later on.

At any rate, it is now apparent that it is better and more economical to run this liquor away, and instead put nothing but clear water on the leach. We shall then not only get the same amount of tanning substance, but in a more desirable form, as non-tanning substances, such as exist in spent liquors, are carried forward unchanged in the leaches.

The last system of leaching bark which has been described in this chapter is in use by the American Oak Leather Co., Cincinnati, Ohio, and the plant was built by Byron Holbrook, Milwaukee, Wis. The leach house of the American Oak Leather Co., is the most modern in the world, about $25,000 having been spent on it.

Stephen Dow & Co., and E. C. Cottle & Son, Woburn, Mass., and Beggs & Cobb, Winchester, Mass., have recently put in new systems of leaching hemlock bark. The leaches are circular in form, 12 feet in diameter and 14 feet deep. There is a bark conveyer overhead and a conveyer underneath for the spent tan, leaving the leach house clear of obstructions.

The water that goes on the head leach is about 140° F. in temperature, but the water that is put on the tail leaches is at 212° F.

Tanners who use bark are paying greater attention than ever to their leaching systems. The depression in business and lack of profits is forcing manufacturers to economize in every direction, and save all that is possible in their processes. Many tanners are now convinced that it is better to replace old leaches and faulty methods by modern improvements, rather than deceive themselves with apparently saving expenses by sticking to superseded and wasteful methods.

Tanners with old-fashioned square leaches, set in the ground, which have to be laboriously thrown out when spent, are now building the popular round leaches, placed above ground, and supplied with openings at the bottom, through which with little effort a man can quickly feed the spent tan to the conveyer under it.

There seems to be much more inclination among tanners to pump their leaches more frequently. Careful foremen state that the best way is to keep the ground bark covered with liquor, and in this manner prevent channels being formed in the leach. Bark ground finely is particularly apt to pack, unless pumped over carefully and properly. It is said that if a leach is simply pumped off and then refilled, channels are more liable than when there is a good head of liquor on the top of the leach, which percolates evenly, and is as evenly replenished at the top.

Some tanners prefer flooding. Of course, to enable the pumps to be kept working constantly, a certain amount of liquor has to be thrown into storage tanks. Those who are leaving the least percentage of tannin in their bark say they put moderate heat on the new or head-leach, but that the other leaches get red-hot liquor all the time. A successful oak sole leather tanner claims to get 1,000 gallons of 22 degree liquor from 2,000 pounds of oak bark. When asked how many pounds of oak leather he made from a cord of bark, he retired into eloquent silence, feeling that his chief success in meeting competition lay in his ability to manufacture in the most improved manner at the lowest cost, and to keep his own counsel. Numbers of tanners are leaching to-day exactly the same as 20 years ago. They simply pump one leach into another in rotation and not simultaneously, and let it go at that. It is now generally accepted, however, that more can be obtained from bark by having pumps in each leach, and keeping all of them actively at work all day and all night.

The grinding of bark is being done much more carefully than formerly. Some tanners screen their bark after grinding, and throw all coarse pieces into the mill again. Unless bark is thor-

oughly and properly ground it will not leach as it ought to. It is expensive and wasteful to operate poor mills and poor leaching systems. Better for tanners to keep up to date, to incur the expense attendant on improvements, and thus be in line for making leather under the best conditions, and at the lowest cost.

The most enterprising tanners keep a ledger account for each leach. They weigh the bark before grinding, and measure the liquor produced. All this means careful watching and figuring. But it also means stoppage of leaks, and as well as an intimate knowledge of results that are actually obtained. The path from a fool's paradise to the bankruptcy courts is being trodden every day by weary feet. Chemical analysis has rudely awakened more than one tanner to the true condition of his affairs in his leach-house and elsewhere. If a tanner is satisfied that he is properly exhausting his bark, he should be all the more willing to get a chemist's endorsement of his success. Possibly, however, he may find that after all he was leaving a percentage of tannin which might have been saved. There is undoubtedly a wave of reform in leaching systems, but it is equally true that many tanners are still laboring in old wasteful ruts. Only recently an oak leather tanner confessed that the oak bark that he dusted into his layaways contained much more tannin after being cast out than he imagined. He awoke to the fact that by dumping this bark into a tank and using hot liquors, he was able to exhaust it much better than by simply using cold runs.

What with liquor heaters and coolers of excellent design on the market, cheap pumps and good bark mills, there seems to be no reason why those tanners who claim to be leaving only 1 per cent. or less of tannin in their bark should be as few as they are at present.

One of the best methods for leaching tanning material is that known as the Press-leach system. For oak bark it is specially suited. Any number of leaches up to 12 may be taken to constitute a set. For example, let us take a set of six, which may be arranged in a row of six, or in two rows of three side by

side, and fill each with bark. Each pit leach is fitted with a false bottom raised about 6 inches from the bottom of the pit, through which liquor but not bark may easily pass. A pipe or trunk connects the bottom of No. 1 pit to the top of No. 2, and the whole series is in the same manner connected, so that the liquor passes through each pit of the series on to the top of the next stronger. The liquor from No. 6, the strongest, may be used for the pits. Water or weak liquor is run on to No. 1 and slowly percolates through the bark, passing on to the top of No. 2, and so on up to No. 6, gaining in strength as it advances. By this means the most perfect leaching is accomplished, though in practice it is found difficult thoroughly to spend bark. Before No. 1 is cast, it is necessary to run on one or more hot waters. This dissolves a large amount of "reds" and resinous matters, together with the rest of the tannin, but as the liquor passes through the succeeding pits, which cool down, the reds and resinous matters separate out, and are filtered off. A copper coil under the false bottom of each pit through which steam may be passed is also beneficial.

When the material in No. 1 is spent, it is cast and filled with fresh bark, and becomes the best leach, and is connected to No. 6, No. 2 becoming the spender, and in this manner each pit in its turn becomes the hinder pit. By this system a constant stream of water or weak liquor is run on the top of the weakest pit, and a stream of the strong liquor may be taken from the bottom of the strongest. It saves much labor, pumping, etc., and gives better results than some other systems. A little care must be taken in packing the bark—packing loosely, so that the liquor may flow easily and avoid clogging or channels.

The system which we have described in the earlier part of the chapter is considered by the American tanners to be an improvement on the above, and certainly presents great advantages. The liquor, instead of being allowed, by finding its level, to flow from one pit to the other, is pumped over by an air lift pump attached to each pit, thus keeping the levels in each pit the same. It is important never to let a leach run dry,

as the material by so doing sinks down and becomes sodden, and is liable to heat, and prevents proper percolation.

THE BARKOMETER.

In the use of the hydrometer, or barkometer as it is commonly termed by tanners, it must be kept in mind that it is designed simply to determine the density of any fluid more dense than water, as compared with pure water. It does not indicate of what the fluid consists; the density, or specific gravity, of other heavy fluids can be shown just as readily as that of a solution of tannin, and be indicated on the stem in the same way. The purity, or comparative purity, of a tanning liquor being known, the barkometer will show its comparative value.

The barkometer is graded so that when it is placed in water at 60° temperature it will stand at 0°, and the tanning liquors to be weighed by it should be at the same temperature; but as fluids contract and expand largely as they are cooled or heated, if the liquor is warmer than 60°, the barkometer will indicate less density than it should; if colder, greater density. This shows the value of a thermometer, to be used in connection with a barkometer, as the sense of touch cannot be relied upon to indicate the degree of heat. Barkometers made of glass are more reliable than any others, for they expand and contract less, and although in preparing the liquors it is not uncommon also to judge of their strength by the taste, still this is not a good guide, and no tanner can afford to be without a barkometer.

It is perhaps necessary also to remark that this instrument is applicable only to freshly-made liquors; for otherwise confusion and want of confidence might ensue upon finding that it sinks, sometimes, to a corresponding degree in spent liquor, and which is owing to the fact that the alterations which tanning liquors undergo during use and exposure may not diminish their density, though they impair and destroy their tanning power.

BARK MILLS.

Oak and hemlock bark are the standard tanning materials of the United States. In Europe and other foreign countries the following materials are principally used—valonia, myrabolans, gambier, sumac, divi-divi, mimosa bark, quebracho, bark of the oak, fir and less important trees, and bark extracts. The manipulation of bark so that its tannin can be extracted is a problem that has attracted the attention of many ingenious minds. Numbers of patents have been secured for machines and appliances for peeling, rossing, cutting, grinding, crushing and rolling bark.

In days gone by, when bark was plentiful, it was lavishly and wastefully used. It is not more than ten years ago since even the best tanners in this country were getting much less tannin from their bark than they are to-day.

Bark is liable to be placed before the tanner in three different conditions—dry, damp or green. These differences have called forth special methods for handling bark in any stage to the best advantage. Many theories have been advanced in regard to the best methods of preparing bark so that its tannin can be most thoroughly extracted.

A study of the Patent Office reports, relating to the machines and appliances for reducing bark, is very interesting. It is to be regretted that the very old records are so bare of details. They simply mention the date of the patent and the name of the patentee. Modern reports from the Patent Office give as full information in regard to patents as could be desired. A somewhat melancholy history is attached to the various bark mill patents. One can easily imagine the "big thing" that the inventors thought they possessed in patents which have been forgotten long ago. We suppose many of the inventions did good service in their day, and did not sink into obscurity without yielding some compensation to those who thought them out.

The earliest patent for a bark mill is dated October 25, 1826, and was awarded to C. Foss. This machine consisted of six-

teen knives on a swiftly revolving wheel. It certainly cut the bark, but in a crude and wasteful manner. It is instructive to recall this patent, remembering that we have bark cutters to-day that work on the same principle, although vastly improved in every respect. In 1828, A. Bull received a patent for a bark mill. This was on the segment plan which is so familiar to-day.

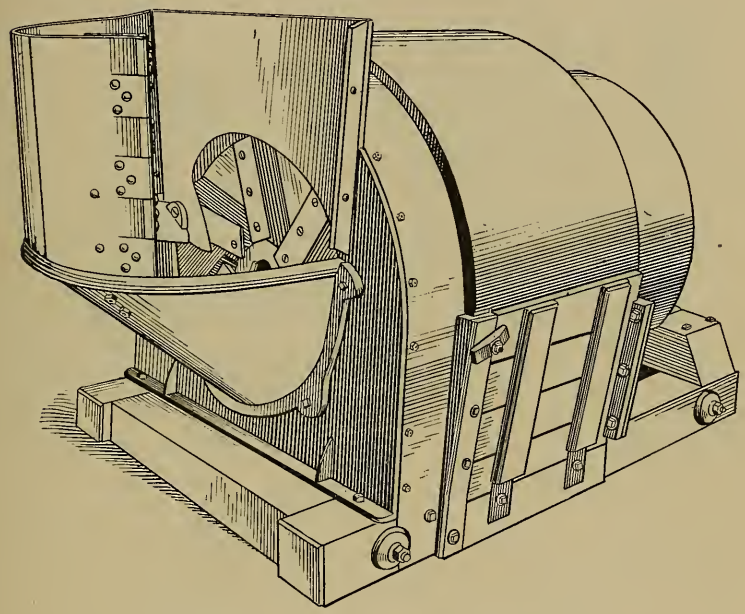
Then followed a number of inventions for breaking the bark in different ways in a hopper, from which it fell between metal teeth or segments arranged in different ingenious ways to pulverize the bark, and render it easy for leaching.

The main object of tanners is to break up the bark so that the tannin-cells can be easily dissolved by water or weak liquors. At present there are two leading methods of grinding or reducing bark. Many tanners advocate what is called the Beecher system of grinding between segments. Other tanners favor cutting or shaving, to reduce the bark into shreds which can be readily leached. A few years ago attention was called to bark-rolling machines. The idea was to take freshly ground bark, and to place it under heavy metal rollers, so that the bark cells could be flattened out and in a way that would yield their tannin easily when soaked. It took so much power to drive these rollers that their use has been confined to comparatively few places.

There have been fads in the bark business just as in every other line. Many years ago it was considered wise to remove the ross or outside covering from the bark before it was ground in the mill. Elaborate theories were advanced proving that the flesh or part of the bark next to the tree containing the tannin would be more profitable to use by itself in the leaches. It was found, however, that the time and trouble necessary to take off the ross was not repaid by results. Tanners acknowledge to-day that while the ross of the bark is not a tanning agent, it contains certain properties when ground in with the flesh of the bark that help to make good leather. Besides, the value of ross as fuel is no small item in a large tannery. We can well recall the time, some twelve years ago, when O. K.

Lapham, who then lived in Chicago, introduced Dr. H. E. Starcke to the tanners of the United States. Mr. Lapham was a student of the properties of bark, and in common with James E. Mooney and the late Jackson S. Schultz, he employed this young German chemist to analyze some alleged "spent tan" from leading tanneries. The analyses startled and aroused the tanners, who were disposed at first to doubt their accuracy. The chemist's science, however, stood the tests brought against

FIG. 4.



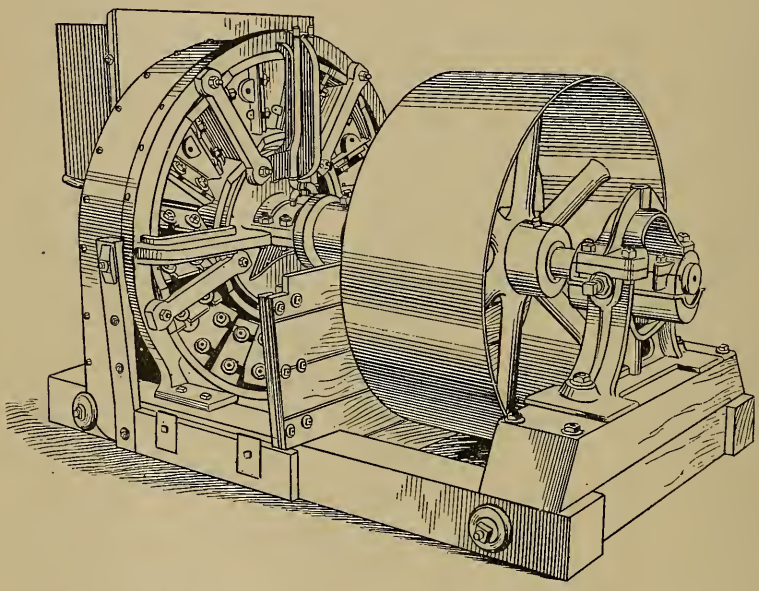
FRONT VIEW.—BARK CUTTER.—(JONES' PATENTS.)

it, and an era of reform was inaugurated in the manipulation of bark which is still active to-day. With improved bark mills, and a better understanding of the methods of leaching, much less tannin is wasted than formerly. There is still, however, room for improvement in the latter direction. It would seem almost impossible to surpass the machines now on the market for grinding or cutting bark.

Bark mills are manufactured by Ott's Bark Shaving Mill Co., La Crosse, Wis.; Byron Holbrook, Milwaukee, Wis.; Eureka Bark Mill Co., Lancaster, Pa.; W. F. Mosser & Son, Allentown, Pa., and Shapley and Wells, Binghamton, N. Y. J. T. Phillips, Grand Rapids, Mich., makes a disintegrator which is valuable to bark users, and is claimed to furnish results not to be had by the use of any other machine on the market.

We show in Figs. 4 and 5 a front and rear view of a bark

FIG. 5.



REAR VIEW.—BARK CUTTER.—(JONES' PATENTS.)

cutter made by the Vaughn Machine Company, Peabody, Mass., and which is largely used by tanners in all parts of this country and in many parts of Europe.

A prominent tanner writes the builders as follows: "That after a thorough test of four months with the cutter they are satisfied that it better prepares the bark for leaching, and gives better results in every way, than any other machine they have known in 35 years' experience as tanners."

In construction it is simplicity itself, with no gears, chains and apparatus to get out of order. There are two discs, the front or breaking disc revolving, and the rear or fine cutting disc stationary. The bark is thrown into the hopper in front by armfuls, when the revolving disc, in which are set six knives, cuts or breaks it up into small pieces, which then pass through compartments in the revolving disc onto the face of the rear disc, around which it is carried until cut up fine by the twenty knives which are set in this disc, and passed through the small throats or apertures in which these knives are set, and falls down into the conveyer at the rear of the same. All practical tanners will see that the bark being cut up into small pieces by the first disc, before reaching the knives where it is cut fine, it is impossible to get large shavings, which cannot be avoided in any other way.

One excellent feature also is that the rear or stationary disc is made sectional, there being five sections with four knives in each one, so there is absolutely no trouble nor time lost in sharpening, as each mill is fitted with two complete sets of sections and knives; thus, when the knives become dull, the sections can in a few minutes' time be taken out and replaced with the sections containing sharp ones, which virtually gives the purchaser the wear of two mills, as the sections are the principal parts that will wear out. This cutter is strictly portable and costs very little to set up; no more in fact than for an ordinary machine, as it has simply to be bolted down to the floor over the conveyer or elevator shute, and belted onto from a countershaft above.

Solidity is another feature the builders claim, and any tanner will appreciate that point and to get a bark cutter that will not break nor get out of order easily.

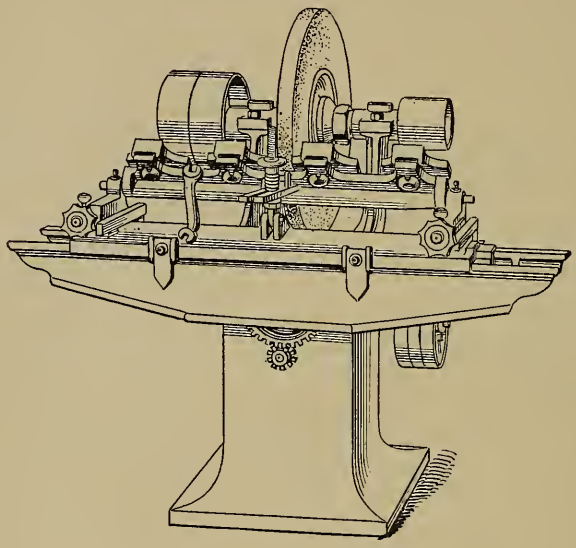
The weight complete is 4000 lbs.: speed from 250 to 300 revolutions per minute. Pulley used 36 inches diameter, 12 inches face. Dimensions: 6 ft. long, 4 ft. wide, 4 ft. high.

Capacity: The builders claim for it 30 cords per day, wet or dry, and guarantee that the quality as well as the quantity done will suit the most exacting.

In Fig. 6 is shown the new automatic knife grinder for the Jones patent bark cutter and other cutters. It weighs only 700 pounds, and is simple, durable and effective.

Emery wheel made special and can be run dry or in water as preferred. Warranted not to heat or draw temper of the knife. Sizes: 32 inch, 36 inch, 50 inch. Emery wheel, 22

FIG. 6.



AUTOMATIC KNIFE GRINDER.

inch diameter, 1½ inch face. Driving pulleys, 10 inch diameter, 3 inch face, tight and loose, and warranted to run 140 revolutions per minute. This machine is built by the Vaughn Machine Company, Peabody, Mass.

BARK-CONVEYER.

This invention, which was patented May 1, 1883, by Mr. Oliver A. Zane, of Peabody, Massachusetts, relates to the endless chains and lags or devices connected therewith for conveying bark or various other matters from one position to another, it being specially useful for what in tanneries are termed

"ground-bark conveyers," each of which in the main consists of an endless chain and a series of lags or bars, such lags or bars being arranged at equal distances apart and fixed or held to the chain, and the latter being extended around and supported by two spider or sprocket wheels. The conveyer so constructed is arranged to extend within a trough, through which, lengthwise of it, the chain in moving drags the lags and causes them to

Fig. 7.

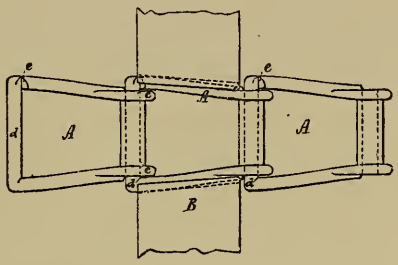


Fig. 8.

Fig. 9.

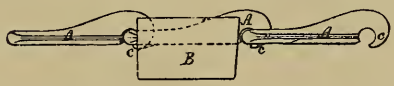


Fig. 10.

Fig. 11.

force along with them the bark or material to be transferred from one position to another or higher one.

Fig. 7 is a top view, Fig. 8 a longitudinal section, Fig. 9 a side view, and Fig. 10 a transverse section, of part of a conveyer containing Zane's improvement. Fig. 11 is an edge view of one of the links of the endless chain of such conveyer. Fig. 12

is a rear elevation, and Fig. 13 a front elevation, of one of the lags of the conveyer.

Previous to this invention it had been customary to construct certain links of the chain with ears extending from them and formed as shown in Figs. 14 and 15 at *a a*, the lag being fastened to the link by screws passing through the ears. These ears are very liable to become broken from the link, and thereby render it useless, and to necessitate the substitution of another, frequently at considerable expense, inconvenience, or loss to the tanner. With this invention the links of the chain are all alike and require no such means of connection of any of

Fig. 12.

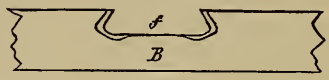


Fig. 13.

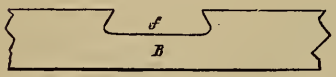


Fig. 14.

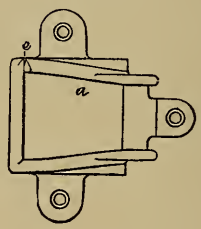
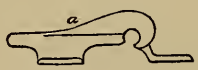


Fig. 15.



them with a lag, which may be attached to any one of them throughout the chain. In Figs. 7, 8, 9, and 10, these links are shown at *A A A* and a lag at *B*. Each link tapers lengthwise and crosswise; or, in other words, it is not only dovetailed in form lengthwise of it, but is also dovetailed transversely of it, as represented. It is hooked, as shown at *c*, at one end to clasp the cylindrical end part, *d*, of the next link, each link being notched as shown at *e* and *g*, to enable it to be coupled with or uncoupled from another link. The lag *B* has made in it a notch or recess, *f*, to receive a link, such notch or recess being tapering or dovetailed both lengthwise and transversely of it to receive and fit to a link, which, previous to being engaged with

its two next adjacent links, between which it is to extend, is to be placed within the notch or recess. Instead of this double dovetailed notch or recess being formed immediately within the bar or lag, it may be in a block or piece of metal screwed or fastened to the lag. While the dovetails of the link will keep the lag from slipping off the link in one direction transversely and in another lengthwise of it, the next link, by extending transversely beyond the lag-link, as shown, will prevent the lag from slipping off its link in the opposite direction longitudinally of the link. Thus by having to the lag a double dovetailed recess or link-socket, as described, and by having the chain-links made as represented, it is possible not only to readily adapt a lag to any link of the chain, but also to keep it in place without any screws, ears, or other fastenings, as heretofore employed; and when a tanner is provided with auxiliary links he can, in case of breakage of any one of the chains, readily supply its place with another.

Instead of a lag, a bucket may be used, and be provided with a double dovetailed recess or link-socket, as described, to receive a link of the chain.

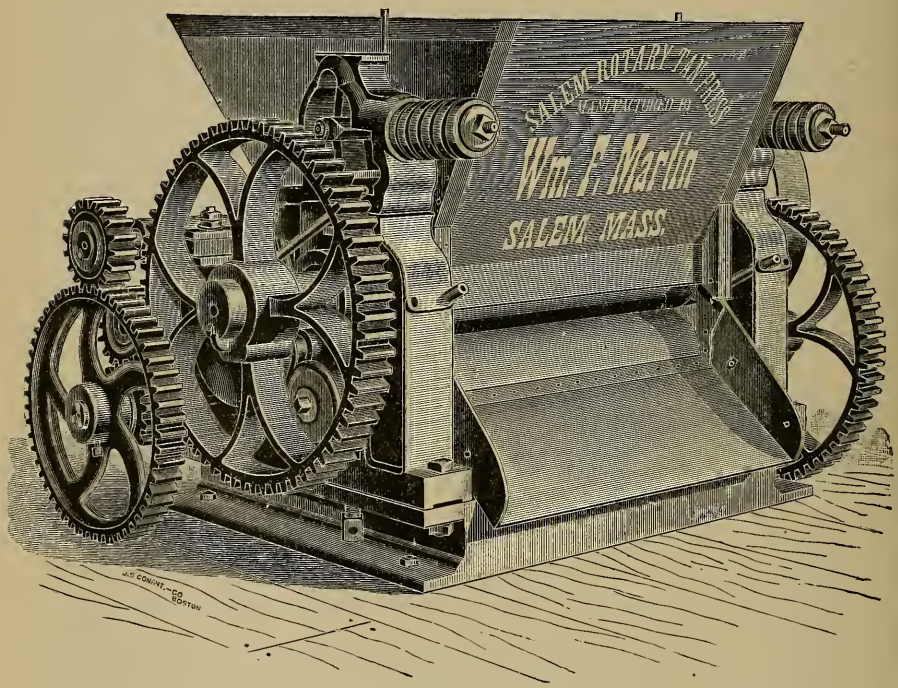
THE TAN PRESS.

The machine shown in Fig. 16 is made by William F. Martin, Salem, Mass., and is indispensable in every well equipped tannery, for the preparation of the spent tan for fuel. The machine is compact, simple in construction, and easily kept in order. Ten cords of wet dripping tan can be run through the press in a day, pressed dry, and it is ready to burn under the boiler without the addition of coal or any other fuel. At this late day it is perhaps unnecessary to speak of the economy of a tan press over drying the tan in the sun, or over the boiler, or having it carted away as waste. Suffice it to say, that no tanner who has used a press would think of doing business without one.

Yet as some tanners are still doing business without a press, it may be said to them that the economy of one is this: That

by the means of an elevator, consisting of buckets on an endless chain, the spent tan is taken from some convenient depository near the vats or leaches, to a bin above the tan press. It feeds itself through, and is from there deposited in front of the boiler, where it is ready to burn, thereby saving all labor except the little of getting the tan to the place where it is first taken

FIG. 16.



SALEM ROTARY TAN PRESS.

up by the elevator. Thus is there a good fuel convenient for use at almost no cost.

Diagram of press is shown in Fig. 17. After the tan has been thrown into the hopper *D* it is then forced by the fluted feed roll *B* through the pressure rolls *A A*, and sliding down delivery plate *E*, it falls in front of the boiler ready to be

shoveled into the furnace. The water is taken care of by the revolving brass strainer roll *C*.

The press is run by a 4 in. belt, requires but little power and should be run at a speed of 75 revolutions.

FIG. 17.

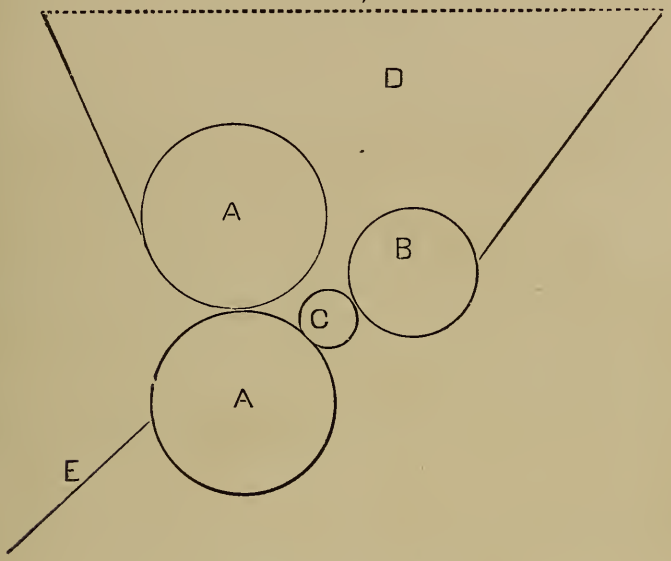


DIAGRAM OF TAN PRESS.

CHAPTER V.

TANNING EXTRACTS.

THE use of extracts in tanning has grown to large proportions during the past fifteen years. There are many advantages in the use of such extracts. The liquors are always under perfect control, that is, by putting in so much extract the quantity of tanning material is known. It does away with the storing of large quantities of bark, as one barrel of extract is equivalent to about one cord of bark—128 cubic feet. Where space costs money this is quite an item, and it also saves interest and insurance on the bark.

There is no difference in the fibre produced by bark liquors and pure tanning extracts, as properly prepared extract is nothing more than concentrated liquor. Tanning extracts in common use in the United States are made from chestnut oak bark, chestnut oak wood, chestnut wood, hemlock bark, quercitron bark, canaigre and sumac; black oak bark extract is used to give a bloom to leather, and coloring or dyeing extracts are made from logwood, fustic and from a large number of other materials.

The chestnut tree, after it is felled, is peeled of the bark, which is objectionable on account of the coloring matter which it contains. The chestnut oak tree is used as it comes from the stump. The chestnut tree and the chestnut oak tree are cut into suitable lengths, say about four feet long, in the forest. These pieces are then carried to the factory, where they are further reduced by "chipping" by a machine built especially for the purpose. This machine is a cast steel disk four feet in diameter, revolving rapidly and carrying a suitable arrangement of knives, which cut the wood into small chips. These chips

are carried to the leaches and leached or extracted as is usual in tanneries. No chemicals should be used in the leaches. The liquor is then run into settling tanks, and next passed through ten wire cloth strainers of the finest meshes to clarify it, after which the liquor goes to the vacuum pan and is concentrated under diminished pressure at a temperature of between 120° and 140° F.

The above described method of settling and straining is the one in common use in the United States, and it produces a liquor which is pure and transparent enough to be made into an extract suitable for tanneries.

When the degree of heat has been carried too high in the leaches, such liquor can only be clarified sufficiently by 1st. Lowering the temperature below the coagulating point of blood and adding blood; 2nd. Raising the temperature of the liquor sufficiently high to coagulate the blood, which gathers up the fine suspended matter and settles to the bottom of the vat or tank, and is then still further strained. It is then concentrated as usual.

Extract, however, made from a liquor which has been produced at too high a degree of heat—although clarified by blood albumen—will not produce a satisfactory article; that is, such an extract is not strictly speaking a concentrated liquor.

The extract maker, it is true, obtains a larger yield or number of pounds of finished extract from his material; but it is at the expense of the tanner. The excessive degree of heat in the leaches extracts not only non-tanning substances, which are objectionable, but destroys also certain bodies which act favorably in the production of leather.

In the concentration of the liquor in the vacuum pan extreme caution must be observed as to the degree of heat. A temperature of over 140° F. or thereabouts produces a change in the tanning substances and in its allied non-tanning substances, which is very objectionable, and which produces an undesirable leather, not only in color but in quality. In other words a liquor although carefully made, when subjected in the pan to

a degree of heat in excess of 140° F. or thereabouts, yields an extract, which, when diluted with water, is not what it was before concentration. It is on this account that the multiple vacuum pans—that is, more than one pan—can not successfully be used in the concentration of liquors or the making of extracts.

In the use of extracts the tanner should always be on the lookout for only the pure article, free from adulterations of any kind. Extract is now being used extensively for sole, upper, belting, harness, union, enameled and patent leather, and in nearly all the cases which have fallen under our observation giving good results in both tannage and weight.

There are various methods followed in the preparation of hemlock extract, but that used by a prominent extract company in Pennsylvania is a good one. The bark is ground in the old-fashioned mill, and is very carefully leached in the old-fashioned way and boiled down in the vacuum pan under the least degree of heat that can be employed. No chemicals whatever are used. They do not press or crush their bark to get from it a larger yield, but are doing their best to give a pure article which will produce a pure, strong, old-fashioned liquor. They take a good, fresh 10° barkometer liquor and boil it down to 27½° Baumé in vacuum. There is no other description than this, for this is all they do.

The boiling point of water varies according to the pressure. With a pressure of 29.2 inches, it boils at 212°; with a pressure of 27.74 inches it boils at 208° F. In a vacuum water will boil at 67° F. Advantage is taken of this fact in the extraction of sugar. The application of heat in the ordinary way converts a large quantity of crystallizable sugar into an uncrystallizable state, thus causing a serious loss. By effecting the concentration in a vacuum it takes place in a much lower temperature and prevents this source of loss.

The manufacture of tanning extracts now closely resembles the process for extracting sugar; the sliced wood is exhausted by diffusion in autoclaves under slight pressure, and the liquor

is filter-pressed and evaporated in some cases in triple-effect apparatus which differs from those used at the sugar works merely in being constructed entirely of copper and bronze, to the exclusion of iron, and in being worked at a higher vacuum than sugar pans are. Most manufacturers decolorize the liquor before concentration, either by the addition of some metallic salt or with albumen and bisulphite of soda. In the former case the acid of the salt remains in the extract, and in the latter sulphate of soda and non-coagulable albuminoids are retained, whilst in both cases tannin is necessarily precipitated. The presence of salts in tanning extracts is much to be deprecated, since they accumulate in the tan pits to the detriment of the leather.

Roy has shown that the so-called decolorizing processes are beneficial to the extract, not because they eliminate coloring matters, for they do this in a very minor degree, the color of the liquor after treatment being but slightly diminished if estimated on the basis of equality of tannin content—but because they precipitate, together with the first portions of tannin, certain earthy and metallic bases, such as lime, magnesia, manganese, iron and copper, derived from the wood and from the apparatus. It is these foreign matters which are taken up, combined with tannin, by the leather, imparting bad color and harsh and brittle grain. By substituting an aqueous solution of potassium ferrocyanide for the precipitate previously used, Roy has succeeded in removing these metallic compounds without appreciably decolorizing the extract, and finds that the leather produced by the treated extract is in every way comparable with that prepared with oak bark liquor made in the tan-yard.

It follows that tanning extracts must be examined for salts of the alkalies and alkaline earths, and for metallic compounds, and valued in accordance with their content of these, as well as with their content of tannin.

CHAPTER VI.

SOAKING AND SOFTENING.

WHERE it is possible to do so, the hides should be carried through whole until the tanning process is completed and then cut into sides.

The hides should not be soaked in putrid soaks, as valuable gelatine is thereby destroyed—fresh water being cheap.

A German tanner, speaking of soaking, says that good economical practice requires great care to be taken in soaking hides. He uses principally cow-hides averaging 60 to 70 pounds in weight, and they reach him salted. He says that his first work is to free these hides from dirt and salt. Economic methods require that the hide should not be handled oftener than is absolutely necessary, and this can only be avoided by systematic arrangements as to the progress of the various stages. Soaking hides in wheels with a constant in and out flow of water is one of these methods which is supposed to soften and cleanse the hide. It does it, but alas, too much so! The salt has so acted on the hide that its most valuable constituents, which are very soluble, are easily washed out, especially from the thinner portions of the hide, which will show with a heavy loss in the finished leather. The same danger is incurred in soaking hides in the common tumbling barrel, drum or wheel. Better results are obtained from a wheel divided into four compartments. The falling and heavy beating of the hide from one side of the wheel to the other is thus prevented, and the movements are more gentle and of a rolling nature. The simplest and best method is soaking in a water pit or box. He prefers a number of such pits, made of masonry and cemented, arranged in a row. Three or four of

such will be enough for an ordinary tannery. They should be arranged with a waste pipe to empty them, and large enough to hang the hides in their full length. The hides can then be transferred from one pit to another. Two days' soaking, with four changes of water, is sufficient to cleanse the hides thoroughly. Hanging the hides is better than throwing them in, as it saves labor, and gives them a more even soaking. The best plan is to hang the hides on sticks the length of the back bone, low enough to be covered by the water, draw the plug every twenty-four hours, rinse off salt and sediment and run in fresh water.

Green or native slaughtered hides cannot be too soon put into work, for it is true that as soon as life ceases decomposition commences, except a detergent be applied. Salt is very generally used for this purpose, and is effective, although not the least injurious agent that might be used. Some have a great aversion to salt, but it is one of the easiest evils to remove. Borax is a better agent than salt for preserving hides and skins, and is very easily removed by soaking.

Dried hides and skins are too various to particularize, and require a variation in soaking, depilating and cleansing from the depilator before tanning is commenced, if a good return is expected. Green hides and skins should first be well cleansed from dung, dirt and any extraneous blood there may be remaining on them, and then well soaked from two to six hours, according to the kind of skin or hide.

The preparation of hides and skins should commence by first cleansing them from dirt, salt and blood previous to using any depilatory process—more especially from blood or albumen, as they deteriorate all kinds of leather where any portion is left in, and prevent a full expansion of the fibrine, which should be fully extended and clean, that the tannic acid may have free access to and form the chemical combination with it; salt also should be thoroughly eradicated; then we have the hide or skin free to operate on for depilation. What are called green or native hides and skins are very frequently saturated with salt to pre-

serve them in transit to the market, or to keep them from week to week, and are often stored by the tanner previous to putting into work. These are generally subjected to a washing in pits. This we would call a partial cleansing, but not an eradication of either salt or blood, although a gradual decomposing of the pelt, and the first step toward reducing the quality, weight and profit.

Foreign salted hides and skins are subjected to the same kind of treatment, but for a longer space of time, and from the lengthened time they have been in salt, which has extracted much of the water of the pelt, it does not act so quickly; yet before it is considered fit for lime, or other depilator, the same waste commences as in home slaughtered hides treated by this mode.

Dry salted hides, kips, etc., require a longer time to get them into a state fit for the depilatory process. These are generally put into a pit of water kept for the purpose, called a soak, and used from time to time until it becomes quite putrid. The staler it is the more effectively it softens the pelt, but often it is found that the flanks and thinner parts are damaged or decomposed before the stout parts or shanks and heads are rendered as soft as the pelt should be in a natural state, and must be made before liming, etc.

Dried hides and skins are still more difficult to bring back to the state they were in when taken off the animal, because of the carelessness in drying before they are stored or packed. There is much uncertainty about the soundness of every part of the hide. Defects do not show themselves till put into work; then every part that has not been perfectly dry or has been tainted before drying, will appear either by the hair coming off, the grain peeling, or often large portions of the hide rotting away. Even when the hides are perfect, the soft and thin parts are damaged by decomposition before the thick, hard parts are nearly soaked, although stocks or tumblers are used to facilitate the softening; yet three or four weeks are often occupied in this preparation by the general mode, the

uncertainty of which causes this class of hides to be much neglected by our tanners, though they should be the most remunerative in our trade, the leather produced from them meeting with ready sale. Various modes for improving the preparation of this class of hides have been brought forward, and some experiments have been made, but there has not been much progress in this direction.

Dry foreign hides and skins have long been neglected by tanners on account of the difficulty of bringing them back to the soft state they were in when taken off the animal, and the uncertainty of getting the whole of the pelt into a state that will make leather. This arises from two causes—first, from the hides being imperfectly dried, for when any moisture is left in, before packing for transit or storing, although it may not be observable to the eye of the purchaser, they will rot in the soak, and be worse when put into lime or other depilator. Another very general cause is that, with present modes of softening by stale foul soaks, the thinner parts are deteriorated before the stout parts are softened.

The tanner has no control over the first cause and cannot guard against it except by buying at a price that will allow for these defects; but the latter cause may be avoided if a suitable soaking liquor is used. This has been accomplished by the aid of chemistry, and results prove that the foul soak may be dispensed with, not only without loss, but with increased profit. The coarse buffalo will yield to this chemical soak, and the hard dry calf will be made fit for glove kid.

While speaking of this important part of preparing the hide or skin we would draw attention to the necessity of its being done thoroughly. Too much care cannot be taken at this stage, for if the pelt is not fully developed it cannot be remedied afterward. Such a soak should be used that no danger is to be feared from leaving in till every part is fit for the depilatory process, yet the weaker parts not injured. Stocks, drums and tumblers are a great acquisition, but chemical aid united to mechanical skill crowns the whole.

The usual mode of softening dry hides for sole leather by putting them in stale old soaks is very offensive, and very prejudicial to the pelt, as most tanners know to their cost. Some lessen the risk by putting them through stocks or tumblers; but many tanners still do without the aid of machinery in this part of the preparation, forgetting that the longer the hide is in a foul soak, the less weight of leather will be realized, through the weaker parts exuding their gelatine. This is one of the causes of old soaks being so offensive, as every addition decomposes and increases the nuisance.

We would recommend a chemical soak that might be used with or without the aid of machinery, although stocks or tumblers are a great acquisition, not only in the saving of time, but in preventing loss, for the more quickly a hide is softened the less is drained out of it. The time for various kinds will differ, but from our own observation we should say East India kips put into clean water over night may be softened by aid of machinery in three hours the next morning, or without mechanical aid, in two days or less, dry calf in proportionate time. Dry buffaloes, soaked in the same way twenty-four hours, we have seen well softened with six hours' tumbling; still, we would not place too much value upon speed alone. We should remember it is quality and weight that is the desideratum, and judgment must be used to get the hide back as near to its natural state as possible before it touches any depilatory composition or liquor, which roughly we would say may be done, from calfskin to buffalo or dry flint hide, in from six hours to three days.

Dry salted skins will soak more regularly than skins that are simply dried, but these, where machinery is not used, should be well worked over the fleshing beam daily until they are in good condition. Plain dried skins should always be worked over the beam after the first few hours' soaking, for there are many folds about the edges that even with machinery will not open so as to soften properly unless this is done, and the same may be profitably practiced with green home-slaughtered hides and skins, for where they are dry at shanks from exposure in

transit, the depilator will injure and not act properly. These also may be advantageously put into a chemical soak for a few hours, to prepare them for the depilating liquor or compound.

All hides and skins, if not bruised by tumblers or stocks, should be well worked over the fleshing beam till the loose flesh is thoroughly softened and pulpy. If this is not done it is impossible for the pelt to progress satisfactorily. Some say the nerve must be broken, but it is sufficient if the veins and membranes are so softened that they rise from the true skin. They will then allow the liquors to pass through the flesh to be easily removed after unhairing.

Borax, as is well known, is largely used in laundries for softening the water, and by packers for preserving meats. It must, therefore, prove an invaluable agent to tanners. To soften 1,000 gallons of water, five pounds of borax are used. It is dissolved in boiling water, poured into the vat or tank under vigorous stirring. Borax is one of the gentlest of the alkalies, and is one of the most perfect of the cleansers. It is equally applicable to all kinds of leather, and it will pay all leather manufacturers to use it in their soaks. The Pacific Coast Borax Co., New York, Chicago and San Francisco, are the largest producers of it in this country.

Borax and alum in combination will soften very hard water. by removing all the mineral matter and impurities, leaves the water pure and soft. Nearly all other chemicals and compounds used for the purification and softening of water leave traces of their presence behind, which very often give more trouble than the primary cause which it was sought to remove.

By using pure water in the soaks the use of destructive chemicals is not only minimized but the very best results are obtained at much less cost than where impure water is employed. At a cost of seven cents for borax and alum, one thousand gallons of water can be purified and made soft.

Most natural waters, as is well known, contain small quantities of alkaline salts and earth. In using such waters for swelling, cleansing and washing the hides, the swelling influence

which these salts have upon the coriin must be taken into consideration.

In hard water containing much of these salts the skins must remain for a shorter time than in soft water, that is, such as contains but a small quantity of salts or none whatever.

Soaking calf-kid and light hides depends on the weather. Ten hours will be enough if the chill is off the water. Steam can be used in winter time, but with judgment.

SOFTENING.

It is usual to soften dry hides and skins in the hide-mill after they come from the soaks and have been divided into "sides," and previous to subjecting them to the liming process, and the time which they are worked in this mill depends upon the hardness or softness of the hides or skins. For the sides that are intended to be worked for upper leather, the usual time is from one-quarter to three-quarters of an hour, while skins that are intended for the production of morocco and kid leathers are usually worked from ten to twenty minutes.

The construction of hide-mills differs greatly for the various branches of leather manufacture. Those employed for softening hides and kips are similar to the fulling mills common in woolen factories; while the mills used for manipulating skins, such as goat and sheep skins intended for the production of morocco and kid leathers, are sometimes in the form of a large revolving drum, the interior of which has a number of oak pins attached securely to it, and so arranged as to soften the skins as they fall upon them, or in other ways continually come in contact with the pins. The number of skins placed in a mill of this kind at one time is from one hundred and fifty to two hundred, and the morocco and kid tanners where it is used, call it a "pin-mill."

The morocco and kid tanners of Philadelphia, Penna., employ, sometimes, a softening mill for the dry skins of a very different construction, which consists of a central, vertical, or upright shaft, on the top of which is keyed a beveled-wheel, which

meshes with a suitable pinion. About two feet above the socket in which the upright shaft revolves, and passing through and secured firmly to the main shaft, is a second shaft about fourteen feet long, and extending horizontally at right angles with the upright shaft so as to divide itself into two arms of equal length. About one foot from the end of each of these arms there is an iron collar secured to the shaft, and against each of these collars a large granite roller, about four feet in diameter and eight inches face, is rested, the ends of the projecting arms of the horizontal shaft passing through the centre of the stone rollers, which are held in place by large iron washers which play loosely on the shaft against a steel pin.

A pit is excavated about three feet deep, following the circle described by the inside vertical face of the two stone rollers.

The socket in which the main or upright shaft revolves is placed on a level with the bottom of the stone rollers, and is supported upon a pedestal firmly planted in the centre of this circular pit.

A workman stands in this pit and arranges the skins under the rollers as they revolve, sometimes exposing the flesh side and at other times the hair side to the rollers, and all the while keeping them moistened by throwing water upon them, which he obtains from the bottom of the pit in which he is standing.

Mills of this kind may have their advantages for softening skins, or they would not be employed by some of the largest morocco and kid tanners in this country; but they are in our opinion both clumsy and dangerous, as it is simply a question of time when one or both hands or arms of the workman who attends them will be crushed by the rapidly revolving stone rollers, and besides the skins are constantly exposed to injury by remaining too long in one position under the rollers.

CHAPTER VII.

DEPILATION OR "UNHAIRING."

LIME.

A DEPILATORY is any substance which has the property of removing hair from hides or skins without injuring the texture.

Some skins with which the tanner has to deal are depilous, that is, without hair, such as alligator skins and skins of animals of the lizard family, which are quadruped, corticated and depilous—that is, without wool, fur or hair.

In leather manufacture hides and skins are steeped in a solution of lime in order not only to remove the hair, but at the same time to swell the hide or skin ready for the reception of the tanning liquor.

There are many methods for accomplishing the depilation or unhairing of hides and skins, but it is commonly achieved by placing them in a solution of lime until the hair bulb is loosened, thereby allowing the hair to be readily rubbed or scraped off.

Lime is an alkaline earth of great economic importance. It is the oxide of the metallic base calcium, but neither this metal nor its oxide occurs in nature in the uncombined condition, although existing in enormous quantity in various combinations. Lime, as artificially made for use in the arts, is prepared by calcining limestone or marble, or seashells, in properly constructed furnaces, known generally as lime kilns or simply kilns. By this process the carbonic acid is driven off from the lime, and the latter remains as an infusible amorphous substance, which is white when pure limestone has been employed. In this condition it is commonly known as quicklime. When exposed to the air it attracts moisture and falls into powder with greater or less rapidity, according to the humidity of the atmos-

phere and the quality of the lime. This process is called air-slaking. Lime for tanners' use is slaked by the addition of a large quantity of water, which is absorbed with avidity and with considerable evolution of heat.

There are few limestones which do not contain a greater or less quantity of sand and clay, or of silicates of various bases mixed with the calcareous material.

The lime as prepared from various qualities of rocks varies in character with the nature and amount of this foreign admixture. Limestone containing less than 5 or 6 per cent. of impurities yields a rich or, as it is often called, a fat lime. With more than that amount the lime is poor, and does not augment in bulk to any considerable extent when slaked with water. The rich or fat lime is the one which is of the most importance in tanning.

The use of lime is often inconvenient and in many ways unsatisfactory, as owing to the energetic action which free lime exerts on animal tissues, a considerable portion of the gelatinous tissue of the hide is disintegrated and decomposed during the liming process, and removed from the hide in the form of soluble gelatine, or else so altered as to be rendered incapable of combining with tannin, thereby incurring a serious loss in the weight of leather that should be produced, and in its quality, as the skins or hides treated by this process produce leather less supple and more brittle than is desirable.

These objectionable results are more of a physical than of a chemical character; the principal modifications of the chemical constitution of the hide or skin treated by the lime process are the slight increase in the quantity of lime which it originally contained, and a decrease in the quantity of fatty matters due to the saponification caused by the lime; the harshness and brittleness imparted to the leather being caused not only by the saponification of the fatty matters, but much more so through the presence of the quantity of lime which penetrates into the tissues.

Suppleness being an indispensable requisite for upper, mo-

rocco, and other kinds of leather, it is restored to them after being treated by the lime process by subjecting them to the action of a bating process, performed by immersing the hides or skins in a solution of hen, pigeon or dog manure, bran, coal tar bate, and various other solutions, the object of such treatment being to neutralize the lime contained in the tissues.

This "bating" is usually performed in consequence of the employment of lime for depilating, and as both of these processes are expensive and add largely to the cost of producing all classes of pliable leather, it is much to be desired that some substitute for lime should be found which would be generally acceptable to tanners, and obviate the bating process as well as lessen the expense of unhairing hides and skins.

From the large amount of attention that is being given to the subject of depilating, both in this country and in Europe, and from the tendency of the age to cheapen all the manufactured products of general consumption, we are probably safe in saying that the time is now near at hand when the slow, inconvenient process of depilating by lime must be succeeded by more effective, rapid and economical methods.

Some of the inconveniences of the liming process we recapitulate as follows:

1. The contact of caustic lime alters, more or less, the texture of the hide, and permitting it to penetrate the pores, it remains in them in the state of caustic lime, carbonate, or lime soap.

2. The rinsings in water, bating, and the workings remove it only partially, leaving an impediment to thorough tanning.

3. It also hinders the ready penetration of the tan liquor, and the perfect combination of tannin with the skin, and so obstinately resists removal during all manipulations that a portion is always found in the best leather.

These disadvantages have already led to numerous efforts for the substitution of other agents, which we shall enumerate later on.

The present process to which hides are subjected is termed "raising," and by it the pores are distended, the fibres swollen, and the hair loosened. These results are effected by means of

alkaline or acid solutions, and by sweating or fermentation. Milk of lime, as we have stated, is the alkaline liquor generally employed. Lime water has been proposed as a substitute, but it is less permanent in its action, and requires frequent renewal in order to insure the perfect cleansing of hides.

The primitive manner of removing the hair was to shave it off, but lime was employed even by the early Egyptians. The depilating process, in addition to swelling the hide, thereby loosening the hair and disposing it to yield readily to the depilatory operation, also facilitates, by opening the pores, the absorption of the tannin.

If there be a desire to tan quickly, and produce good and heavy leather, it is highly important that the hides or skins should be properly prepared in the beam house. As the after results depend largely upon the intelligent care bestowed here, much more attention should in practice be given than most tanners are inclined to grant.

All hides that are intended for limed stock should be put in the right condition for the lime—that is, soft enough, but not flaccid, as dried skins may be greatly injured by being softened too much. A hide fresh from the animal is the best criterion as to the condition, for in that state it is best suited for the lime.

When placed in the lime they should be frequently handled or agitated, and should remain in the solution no longer than may be necessary to loosen the hair in order that it may be readily removed.

The ancients and those whom progress has failed to reach, said and the latter say still, "Who limes, tans." Any tanner who entertains such ideas tans his stock without a thought of the difficulties he is creating for the currier.

Lime is a factor at the same time useful and hurtful, and it therefore becomes necessary that the tanner should occupy himself actively with the conduct and the good management of his lime pits, and he should in case of necessity entrust this work only to a reliable man, a good workman.

Most tanners neglect their work at the lime pits, and when

our American calfskin tanners fully realize this point, take care of their lime pits, and see to the intelligent beam work of their stock, they will produce calfskins of the first quality, for we possess better bark for this work than can be found in Normandy or any portion of France.

We shall diverge for a moment and speak of the proper treatment of calfskins in the limes. When the slaughtered calfskins peel they should be immediately taken out of the lime. After having allowed them to drip well, put them in a vat with enough water to cover them without floating. They thus undergo a first disgorging. They may, if necessary, remain in this water for eight or ten days without spoiling. This method is preferable to piling, for while in the water the skins disgorge and the action of the lime is weakened, while in the pile the lime continues its action, and if workmen in piling are not careful to open them evenly the skins get what the curriers call "lime folds," which are almost impossible to eradicate in currying. But best of all, as soon as the skins peel take them out of the lime pits, rinse them and unhair them at once, as promptness in the execution of labor is an economy of capital. From this first stage the work must go on as fast as possible.

Salted calfskins, after being properly soaked, should be put into the dead lime pit, and afterward treated the same as slaughtered stock from this point; but the dry skins require a milder lime liquor than the salted skins and the fresh slaughtered stock. This work is thus rendered a little slower on account of the lime liquor in the dead lime pit having been previously carefully weakened.

Lime in depilating has been at times replaced by acid liquors, but their employment requires the exercise of judgment. The dilute mineral acids make the hair yield easily, but at the same time they swell and soften the hide too much, so that the use of organic acids is preferable. In some tanneries lime is replaced by a mixture of slacked lime and ashes. Through the mutual action of the lime and the carbonate of potassium a caustic alkali is formed, which operates more energetically.

Lime vats are constructed either of timber or of masonry, and in tanneries where hides are worked they are sunk into the ground so that the tops of the vats are on a level with the floor of the beam-house, but in goat and sheep skin tanneries the vats are partly below and partly above the level of the floor.

The vats destined to swell the hides to facilitate the depilation and raising are usually constructed so as to take sides instead of whole hides, the hides being usually split after soaking, which answers for upper leather; but it is very much better for the stock that is intended for sole, belt and harness leather, to lime the whole hides, and then if they are not carried through all the processes of tanning to split them into sides after the liming.

When split previous to liming, the thin portions of the hide, shoulders, etc., contract to a much greater degree than the butts and other thicker portions, and consequently the back line is irregular, which would not be so noticeable if the lime had uniform action on the whole hide, thus economizing the waste in cutting sole and harness leather, but more especially belt leather, where straight back lines are very desirable.

The number of hides determines ordinarily the quantity of lime necessary for each vat. To make a new vat, throw into into it unslacked lump lime, cover with water gradually so as not to drown it, and stir well with a stirrer until slacked and reduced to the consistence of milk. This operation completed, leave it until it is ready to receive the hides. Usually the lime is prepared in a hogshead, and from this poured into the vat, care being observed to retain the sediment in the bottom of the hogshead, which keeps the lime vats cleaner and is beneficial in many respects. The vats are distinguished as dead, weak and live vats, and sometimes as old and fresh limes. The dead or old vat is that which has been frequently used and which has been nearly exhausted of its strength; the weak is that which has been used long enough to deprive it of a portion of its force, and the live or fresh vat is that which has not yet been worked.

It is easy to understand that the live vat becomes successively the weak and the dead vat. When a tanner uses more than three vats he establishes between the dead and the live vats as many middling term vats as convenient, and the whole of the vats are called the raising series.

The raising should be commenced in the dead vat, and continue in consecutive order through the series to the live vat. In some tanneries in Europe the series consists of twelve or more vats, and in that case there should be a graduation in the strength of the liquors. The duration of this operation varies in different localities, as in all portions of Europe the hides are limed for a longer period than with us.

The practice is still in vogue among some tanners of using old limes which are charged with the decomposing matter extracted from previous packs, which practice, in warm weather, becomes extremely hazardous.

The time usually employed for liming different classes of hides and skins will later on be mentioned in chapters devoted to the manufacture of sole, upper, calf, kid and other leathers.

The power reel is now generally employed for handling sole leather hides in the lime vats, and it is the most economical, convenient and effective method, the sides being strung together and passed over the reel from vat to vat.

American tanners put hides through the soaks and limes in about four days. During the last twelve hours of this period the packs lie in hot water. The hides are reeled three or four times during the first day in limes; then reeled twice on the following day from vat to vat. All kinds of fancy schemes have been tried for lessening the destruction of hide substance in the beam-house, but tanners still stick to simple handling, strong limes, hot water and short time. By this method 75 to 80 per cent. of acid hemlock sole leather has been made from plump, well-grown, heavy Texas steers, fall kill. This is good showing, and it is results that count in this busy world.

Every intelligent tanner knows that no exact or arbitrary rules can be given for liming and handling any kind of hides

or skins, as the time required varies greatly, being dependent on kind and condition of the skins, condition of atmosphere, temperature, and temperature of the limes in use, etc.

In the liming of goat skins it is customary to add about one and a half pounds of arsenic to each bushel of lime.

The "arsenic" used is sulphide of arsenic, and when mixed with lime forms sulphide of lime. This acts upon the skin vigorously, hastens the unhairing, and is supposed to give the skin a finer grain than when lime is used alone. This sulphide of lime, however, penetrates to all parts of the skin, and when present in excess does not become thoroughly removed in the subsequent operations of washing, bating, etc. So an excess of arsenic is injurious and would have a tendency to make the grain tight and dry so as to cause skins to crack.

Skins left too long in old limes are apt to have the grain somewhat plumped, and the pores very open, as though not worked out sufficiently.

The grain being loose from the flesh is a common occurrence, and results from a variety of causes. It indicates that some solution into which skins have been placed was too powerful.

There is no way to tell to a certainty whether or not a skin has been sufficiently limed; only long familiarity with the class of skins and their appearance in this state would enable one to form a correct judgment.

Manufacturers of kid are devoting much attention at the present to the "cellar" or "beam-house" department of their works. These gentlemen, having mastered the new chrome process of tanning, are now striving to effect economies and improvements in liming and bating.

Before any real improvements can be made, it is most essential to understand just what it is necesssry to accomplish by these two important operations, and to recognize the fact that rough crude processes which would doubtless give good results on sole leather are entirely unsuitable for kid stock where the final operation, in finishing, is glazing. Roughly speaking, the use of lime is for the purpose of removing the

hair, and the operation of bating for the purpose of removing lime from the stock preparatory to tanning. If this was all to be accomplished, the operations would be comparatively simple, but in the manufacture of glazed stock other important results are necessary to success.

Lime and dog-pure have been used in the beam-house for many years; both are objectionable and have disadvantages, yet owing to their long use experience has taught the workmen their properties, and they know just about how to deal with them in order to attain the desired result. Any other materials which could be used in place of these articles would doubtless bring new and unlooked for difficulties and would require changes in the methods of working in order to make their use a success.

Lime acts upon the roots of the hair; the hair-sheaths are dissolved, thus enabling the hair to be removed on the beam, the hair itself being but slightly altered. The effect of lime upon the skin itself is most marked, and it is the action of the lime other than the removal of the hair, which is most important in the preparation of stock for glazed kid. Lime acts vigorously upon the true skin; the fibres swell and absorb water, so the skins become plump and swollen and at the same time the cement-like substance (coriin), which glues the fibres together, is dissolved and the fibres become differentiated into finer fibrils and so open up the skin, so to speak, in order that it may tan evenly and properly. Another action of the lime is upon the natural fat or oil of the skin, converting it into a more or less insoluble soap, which is largely removed in the subsequent operations to which the stock is subjected. These results therefore are necessary to accomplish by the liming operation.

In the liming of sheepskins consideration should always be given to the removal of the grease. This is most economically done by a wringer. Some large concerns also use presses for this purpose, and some imported sheepskins which have been unhaired, fleshed and split, are soaked in naptha. For making

up a fresh lime for a 4x5x6 feet vat, holding about 900 gallons of water, for liming 190 to 200 large sheepskins, there should be use five or six pails of stone lime. Strengthen next day with three or four pails of stone lime. High liming may kill some little grease, but not sufficient to make first-class leather from greasy sheepskins. Sulphur and lye in correct proportions will not hurt the skin, but we prefer to use commercial sulphide of sodium for strengthening the limes. If lye and sulphur be mixed in definite proportions they will in time combine and form sulphide of sodium. The fresh pulled skins can be entered directly into the new lime; it would be useless to first dilute with water, but it will be found that an older lime will make a better leather than a new lime. It cannot be told by cutting a skin whether or not it has enough lime. Let the limes run into the sewer and thoroughly clean vat about every two months. Some of the clear liquor from this lime that is run off should be used to make up a new lime again.

What can the disease known as the itch possibly have to do with the liming? The itch is a skin disease caused by a parasite lodging under the skin of the living animal. We shall see in the course of this chapter why we speak of the itch in conjunction with liming. It is a fact that a large percentage of all skins suitable for glove kids are more or less scabby. This is very troublesome because for the delicate shades only such skins can be employed as have a perfectly healthy grain, while scabby skins, if not too badly disfigured, can be used only for very dark colors, sometimes also for white or straw color. If the grain is badly disfigured the skins must be finished into undressed kid. A further objection to scabby skins is that besides the disfigurements the quality of the skin has severely suffered. In bad cases even an inexperienced buyer will notice the trouble, but the more hidden symptoms are difficult to notice even by experienced men. The extent of this disease may be judged from the fact that pretty nearly 50 per cent. of all lambskins on Continental markets are scabby. The main difficulty is found in the fact that although most frequent in the

coarser grades, this disease is also quite general among the very highest grades of skins. Thus in France the skins of suckling goats of unequaled quality, of which a dozen are worth $10.00 in the hair, are scabby to the extent of more than 35 per cent., so that often the front half cannot be used for gloves. It requires very experienced skin-buyers in order to get as little scabby stock as possible. It seems strange that otherwise healthy animals should be affected with this skin disease at their birth. This is due to the fact that the disease is inherited from generation to generation. This disease manifests itself in principally two different forms, the prominent and the hidden form. Many tanners, especially lambskin tanners, recognize also a third form which they call the " white itch." The prominent form is readily recognized even by inexperienced eyes, as the scabby spots have often penetrated the entire thickness of the skin from the grain to the flesh, or at any rate are readily seen, particularly in the flanks, by holding the skin against the light. They then appear as dark spots. The hidden form is present only under the grain. On the white glove kid this form can hardly be noticed, but on colored stock it is very prominent. This form of the itch causes all colors, especially the delicate shades, to look clouded and dirty. Skins in the hair affiicted with this hidden form of disease can be picked out only by men of considerable experience by means of the general appearance and symptoms of such skins. The third form, or white itch, consists of a peculiar disfigurement of the grain, which latter looks as if it were covered in places with granulated sugar. This white itch is not the result of any disease, however, but consists of fine crystals of alum and salt deposited on the grain. Only recently a lot of skins that were thus disfigured were sent for investigation to *Der Gerber*, of Vienna. They inquired into the details of the manufacture of this particular lot of skins, and found that the cause of this white effloresence, known as white itch, was the result of using a deficiency of lime and too much arsenic in the limes. This prevented a sufficient loosening of the skin and the result

was that the alum and salt used for tanning were imperfectly absorbed.

DEPILATING WITH SODIUM SULPHIDE.

During the past twenty years much has been writlen and many experiments have been conducted with a view to the introduction of sodium sulphide as a depilatory. At the present time, however, it is generally conceded by all progressive tanners to be an exceedingly useful article in the beam house treatment of hides and skins. Prof. Eitner, in Germany, Prof. Proctor, in England, and Prof. Fiebing, in America, have indorsed it as a valuable material when properly used, and have recommended various methods for its application in the unhairing and swelling of hides and skins. The consensus of opinion now is that to obtain the best results from the use of sodium sulphide lime should be used in connection with it. When lime is added to a solution of sulphide, the latter unites with the calcium to form calcic-sulphydrate and at the same time liberates caustic soda, which considerably increases the unhairing and plumping effect. A similar reaction takes place when the red arsenic is mixed in a solution of lime, a sulphydrate of lime being formed, which is the active agent in producing the desired effect. The use of arsenic sulphide in this way has been favorably known to tanners from very early times, but a substitute for this expensive and exceedingly poisonous material is found in the sodium sulphide, which is much cheaper and just as effective. It is now an established fact that the sulphydrate of lime does not dissolve out so much of the hide substance as when the lime alone is used, and being quicker and more energetic in its action, both time and space are economized in the tannery by its use.

Prof. Fiebing, in writing upon this subject, says, "that the action of lime is throughout solvent and swelling, and more actual hide substance is probably lost by pure liming than by any other unhairing process. The solvent action of an old and fresh lime is nearly the same, while the swelling property de-

creases with age. A material that is steadiiy though slowly gaining in favor is sulphide of sodium. This substance, though not new, is but little understood by the trade. One disadvantage of lime for unhairing hides intended for any leather where a certain degree of solidity and filling are desired, is its property of dissolving the coriïn faster than it will properly loosen and distend the fibres. Consequently, if we lime long enough to properly prepare the hides for the liquor, considerable loss of weight will inevitably follow by reason of the solution of a large amount of coriïn. If a short liming is resorted to, the fibres cannot be properly loosened, and a flat, tinny leather is liable to be the result. Now, we have in sulphide of sodium a material that will efficiently counteract this undesirable property of lime. Sulphide of sodium will loosen and split up the fibres much quicker than lime, and if used in proper proportions will not dissolve as much coriïn as lime. By combinations of these two depilatories we can, therefore, obtain an excellent unhairing agent for almost any kind of leather."

The method of using the sulphide in connection with lime, as recommended by those who have been most successful with it, is to dissolve from one-half to three-quarters of a pound to each hide, and mix it with about the same weight of lime previously slacked. This is thrown in the pit with sufficient water to cover the hides and the hides suspended in the solution. By this method of suspension the action of the depilatory is much more uniform than when the hides are thrown loosely into the pit. The length of time required for the unhairing and the distending and separating of the fibres will depend upon the firmness and flexibility desired in the leather. For sole leather from one to two days should be amply sufficient, while for upper leather a longer time would be necessary. The same kind of mixed depilatory may be used with advantage upon calfskins and goatskins, though in this case the skins may be agitated and their position changed by the use of a paddle wheel attached to the pit, and thereby a uniform action of the depilatory be obtained. There are several grades of sulphide

of sodium now offered in the market, varying in their degree of purity. The common salts occur as crystals of a deep-greenish-black color, and are contaminated by iron sulphide, which produces dark blue stains on the hides and skins. A better sort is found in an amber-colored crystal which is comparatively free from iron. The crystals of sodium sulphide contain 69 per cent. of water and are very deliquescent, and the material should, therefore, be kept in a dry place and from exposure to the air. A new and concentrated form of sodium sulphide, free from iron and free from water, has recently been introduced by the Martin Dennis Chrome Tannage Co., of Newark, N. J., who state that it is more than twice as strong as the ordinary sulphide crystals and of purer quality. It would seem that this form of sulphide should recommend itself to tanners, because many of the objections urged against the older form of the material are removed.

The advantages obtained by the use of sodium sulphide may be enumerated as follows:

1. The unhairing and swelling of the hides or skins is accomplished more quickly, thereby saving both time and space in the tannery.

2. The swelling and distending of the fibres is not attended by so great a loss of hide substance as when lime alone is used, thereby insuring plump and full leather with a minimum loss of weight.

3. The hair and epidermis are so thoroughly loosened that the unhairing operation may be conducted in a wash wheel, thus saving the labor of beam work.

4. The sulphydrates being more soluble than pure lime, it follows that the depilating material can be removed from the hides or skins easily, quickly and inexpensively by mere washing with water. In fact, it is claimed by some that if the wash water is used warm, about 80° to 90° F., no bating will be required, especially in case the hides are intended for sole leather.

Upon these and many other considerations it seems safe to

predict that sodium sulphide will be more and more favorably recognized by tanners as a valuable and almost indispensable material in the art of leather manufacture, and that the future will bring it into much more general use than at present.

This material is also very largely used for wool pulling.

Sodium sulphide is a crystallized chemical substance of definite and regular composition. Any competent chemist can determine its strength. Its value as a depilatory depends solely upon the amount of monosulphide of sodium which it contains, and not upon any patent or so-called improvement whatever. One hundred pounds of crystal sulphide of sodium contain between thirty-one and thirty-three pounds (31 and 33 per cent.) monosulphide of sodium. For the convenience of consumers the dealers in sulphide of sodium guarantee this product to contain at least 31 per cent. of monosulphide of sodium, and if desired, will furnish a chemist's certificate to that effect.

Ordinary sulphide of sodium is frequently sold under a fancy name at a higher price than it is worth.

Tanners are also offered a so-called "improved" sulphide of sodium, wherein the "improvement" consists in adulterating, or weakening, or cheapening it with common sulphate of soda, an article worth on the market less than half a cent a pound.

Both of these are impositions. Fortunately they can be easily detected.

The late John W. Stevens says of the sulphide of sodium process:

"Tanners who are making specialty of imitation goat, bookbinding or pocketbook leather, wherein the leather is split down to a very light substance, should not go too extensively into this process until after several experiments have been made with the sodium, and then by using it in a mild form, for the following reasons: By the use of sulphide of sodium a thicker grain is produced than by the use of lime and hen manure, and when split down to a very light substance the grain becomes tender. Again, leather suited for imitation goat finish must have a thin grain to produce the desired character

and prominence in the print. When too thin, it would be found difficult to throw up a figure in the cork boarding to resemble the real goat skins. In all other respects the quality of the leather is superior, being of a tougher fibre, finer flanks and of a supple and elastic nature, so desirable for fine shoe leather.

"For boot and shoe oil grains, glove grain and imitation calf, where the grain is buffed off in finishing, the sulphide of sodium process is especially adapted, as also for slaughter sole, oak and union crops and backs, which are also submitted to the buffing operation to produce a uniform finish and light color to the soles when made into shoes. This process will also be of great value to tanners making sole and upper leather from dry flint hides. There will always be found in this class of hides many that are sunburnt, particularly those coming from Africa and South America, and it is a difficult matter to work them in warm weather. To soak them sufficiently long to bring the hide back to its original condition, putrefaction would set in, and unless the hides are made pliable before going into the lime, all subsequent labor is lost in the endeavor to produce plump and heavy leather. For a soak of fifty whole hides intended for upper leather, and averaging some twenty pounds each, dissolve one pound of the sulphide of sodium in hot water and pour into the pit, previously filled with cold water: mix thoroughly with plunger and throw in the hides. This has a tendency to not only preserve the hides during the soaking, but will soften up the sunburned portions and greatly facilitate the unhairing process at a later stage. After being immersed two or three days, pull up the hides and examine their condition. Those that have yielded more readily to the water and sodium throw aside, and carry them along by first milling in the wash-wheel without water until a friction is created and the former rigid feeling broken; then let into the wheel a bounteous supply of water until the hides are practically freed from blood, dirt and manure, when they will be in good condition for fleshing. The balance of the pack, should the hides show no sign

of putrefaction, may be thrown back into the soak again after lying in pile a few hours to partially sweat them, when they will soften more readily in the solution. It will not be necessary to run off this solution, but fill the pit again with clear water until the entire pack is soaked. If in cold weather, and the water is cold, the same may be used with some replenishing of water and the sodium for several successive packs, as the ammonia, blood and filth accumulated will facilitate the soaking of dry flint hides; but care must be taken that this may not be carried too far, and that the hides be pulled out frequently, and then select out such as yield more readily. For sole hides of greater average weight, add one-third to one-half more of the sodium in the soaks, and treat in the same way, being careful not to use such a quantity as will loosen the hair too freely while in the soaking process, else a loss of weight would ensue when the hides are later on immersed in the sodium and lime solution for completely removing the hair. For soaking dry kips and calf-skins, a comparatively small amount of sodium per skin would be required, and may be regulated by the average weights, although skins of finer texture require a stronger solution to effect the desired object than do heavy, coarse hides."

The use of sulphide of sodium as a depilating agent is very simple. A definite quantity being weighed off, it is dissolved in a certain amount of warm water. After some stirring the solution is perfected. It is of brown color and clear. It will not deposit on standing, and, therefore, need not be stirred before use. The solution will not ferment, and can therefore be kept for an unlimited length of time. The density of this solution is of no importance; but it is advisable to take twenty quarts of water for every pound of sulphide of sodium. According to the amount of hide worked in per day we must make up a larger or smaller quantity of the solution. The solution can be made up in a cask or barrel. It is imperative to know the concentration of this solution, *i. e.*, we must know how much sulphide of sodium is contained in every quart or gallon of the solution. We recommend a concentration of one pound

of sulphide of sodium for twenty quarts of water. If we add to a lime, say, three pounds of sulphide of sodium, which quantity is about sufficient for an ordinary lime holding about 800 to 1,000 lambskins, according to size of the skins, we must take sixty quarts of above solution. It is not rational to add this entire quantity at once to the lime, but it should rather be given in three or four portions, adding a portion every other day. For every portion of sulphide of sodium solution given we should add one bucket of slacked lime. The slacked lime is dissolved by stirring with cold water, and the requisite quantity of sulphide of sodium is added thereto. This mixture is then added to the limes, and the latter thoroughly plunged. In making up a fresh lime no sulphide of sodium is added at first, in order to give the skins a chance to plump. After the first hauling of the skins the fresh lime is strengthened with above mixture of slacked lime and sulphide of sodium, and this mixture is added for each subsequent strengthening. As regards the relative proportion of sulphide of sodium necessary to accomplish the same work as arsenic, the quantities of both materials are identical, *i. e.*, one pound of sulphide of sodium will do the same work as one pound of arsenic, and *vice versa*.

For an ordinary lime containing about 800 to 1,000 lambskins (according to size), we, therefore, need three pounds of arsenic or else three pounds of sulphide of sodium. The solution of the arsenic can be accomplished by mixing some with lime at the time of slacking and thoroughly stirring. This arsenic-lime paste can also be kept for a long time without spoiling, and can, therefore, be made up in a sufficient quantity to last for a month or so. Of course, the quantity of arsenic contained in a quart or a gallon of the paste must be carefully noted. Another way of dissolving the arsenic is by vigorously stirring it with milk of lime for about half an hour or until the brown color of the mixture has acquired a steel-gray coloration. This mixture is then mixed with milk of lime previously diluted with hot water. The hot water materially aids the solution of the arsenic. The first method of solution is, however, preferable.

The most striking effect of sulphide of sodium in the limes is its property of bringing back the grain to its fresh, green state, even if the skins or hides have become withered by reason of long storage. No other depilatory agent brings about this effect—even arsenic-lime will not restore to the grain its natural green freshness. What we mean by speaking of a withered state of the grain is probably not clear to the majority of tanners. To be sure they have noticed that sometimes the grain of the skins appears clouded, while at other times it is clear after unhairing; but they have never investigated the cause of this fact. Now, the best way to understand just what we mean is to make the following experiment: Take three skins as near alike as possible and unhair one in the ordinary lime, the next in a lime strengthened with arsenic, and the third with sulphide of sodium. Unhair at the same time and spread out alongside of each other, and note the wonderful difference in the appearance of the grain. The one limed with pure lime, particularly if the limes are not fresh, will show a yellowish-gray, clouded grain; the grain of the skin limed in the combination of arsenic and lime will appear clouded and of bluish-gray color, being more pronounced the older the limes; while the last skin, unhaired with sulphide of sodium, will have a clear, fresh grain, closely resembling in appearance a green skin after liming. As we know, those skins that are worked in fresh from the slaughter house, are perfectly clear and very clean on the grain after liming.

Now how is this property of sulphide of sodium explained? Let us first note the fact that the longer a skin has been stored the more noticeable is the clouded appearance of the grain after unhairing, and, vice versa, the fresher a skin is worked in, the clearer, fresher and cleaner is the grain. What is the cause of this cloudiness? It is due to the substances originally held in solution by the blood and lymph of the animal, which have gradually dried out on the grain, becoming more insoluble the longer the skin is stored, until eventually they have become totally insoluble in water. The fact that the impure juices of

the blood can be deposited in considerable quantities on the grain, can be readily observed on the skins and hides of diseased animals. Every tanner knows that the criterion of diseased skins is a remarkable cloudiness of the grain, and that this cloudiness can even be diffused throughout the entire skin to the flesh side. Sometimes not alone the juices of the blood, but the blood itself, can become deposited on the grain. This can be clearly seen on the skins of animals which have died from disease, which invariably show blood spots, and the flesh side of which has a dull appearance. Now that we have found the cause of the clouded appearance of the grain to be due to the deposited matter of the blood, we must next endeavor to discover the means of bringing back this deposited matter to a soluble form. For this purpose sulphide of sodium is without a rival. The dry blood albumens, etc., are so completely dissolved by sulphide of sodium that the grain, after unhairing with this depilatory, is so bright and clean as is otherwise only observed in green butcher stock. Another valuable property of sulphide of sodium is that it does not dissolve the hide substance to any extent if employed at ordinary strength. It can be used in quite concentrated solutions without danger, and it matters little if the skins are left in longer than necessary. Both the hide proper and the grain are usually tough and strong if unhaired with sulphide of sodium. Let us sum up the good qualities of sulphide of sodium:

1st. Tough and strong leather, particularly of the grain.

2d. Closed fibre, well filled leather.

3d. Bright, glossy grain.

But sulphide of sodium also possesses some very undesirable qualities. We have remarked that sulphide of sodium does not dissolve the hide substances to any extent. This property is a decided advantage in some classes of leather, but for glove-kid it is extremely undesirable. Every tanner knows that in order to produce plump, stretchy and good-feeling glove-kid, he must remove a certain amount of hide substance from the skins by means of the depilatory employed. Now as

sulphide of sodium does not possess this solvent property, it follows that by its use we cannot achieve satisfactory results for glove-kid. Sulphide of sodium plumps the stock similar to vitriol. In concentrated solutions it possesses extraordinary plumping qualities. The hair bulbs are speedily dissolved. In fact we can depilate a dry, unsoaked skin with a very concentrated sulphide of sodium solution inside of a few hours; the skin will swell up to five times its natural thickness, and the hair will be loosened sufficiently without dissolving any hide substance. If by this process we treat a skin that has previously been properly soaked, the same operations will be performed inside of a few minutes. This fact led tanners to believe that sulphide of sodium would be an excellent depilatory for glove-kid without the addition of lime, but experiments soon showed that something was lacking, and now sulphide of sodium is never alone employed for depilating glove-kid or alum leather. If sulphide of sodium be employed for any class of glove or upper leather, we must always use sufficient lime with it to dissolve the necessary amount of hide substance. Generally not enough lime is used with sulphide of sodium and the result is flat leather; further, the skins are not equalized, i. e., that thick skins remain thick and thin skins remain thin.

It is another undesirable property of sulphide of sodium that glove-kid, made from skins depilated with this material, get hard and unelastic during the requisite aging. We know by experience that alum tawed glove-kid must age a certain length of time in order that the tawing materials can properly unite with the fibre. We also know by experience the result if this aging is not properly done and the leather goes to the dyer too fresh. If the skins are colored before having had the requisite time of aging, the tawing substance, being only loosely held, will be washed out to such an extent as to result in a hard, hungry leather. The necessary time required for this aging is at least two months, and need never exceed twelve months. A naturally mild leather skin requires only a two months' aging, while a flat, hard skin necessitates from eleven

to twelve months aging before coloring. If sulphide of sodium has been employed as a depilatory we must shorten the time of this aging to the detriment of the leather, for above mentioned reasons. This disagreeable property of leather unhaired with sulphide of sodium becoming hard during the aging is due to the same cause as the flatness of this leather. A green skin is flat and unelastic as compared to well-tanned leather. Why? The naturally loose fibrous network is pasted together, so to say, in its own gelatinous hide substance, which latter has the property of getting harder the more the skin dries out. The depilating process must remove a certain amount of this gelatinous hide substance, and the spaces so formed must be filled by the tawing materials which give to the leather mildness, body and good feel. Inasmuch as sulphide of sodium does not remove an adequate part of this gelatinous hide substance, it is natural that the resulting leather somewhat resembles the green skin in its property of getting hard when it dries out completely and remaining flat. Another bad property of such leather is the difficulty of coloring it, which is also due to the presence of too much of the gelatinous hide substance. To sum up, we can obtain a good-looking glove kid with sulphide of sodium, but it must be quickly sold and at low prices. Manufacturers who endeavor to establish a reputation for their goods cannot use sulphide of sodium for making glove kid.

A writer in *Der Gerber* says: If the practical tanner were satisfied to obtain "similar" effects to those produced by arsenic and for some reason wanted to replace the latter by a substitute, he would find sulphide of sodium best adapted for the purpose. But there is a tremendous difference between "similar" effects and identical effects. It is now about twenty years ago that the first experiments were made with sulphide of sodium in the tannery, and it seemed for a time that a material had been found which would entirely replace the poisonous arsenic. After numerous and careful experiments had, however, been concluded on all classes of hides, from the heaviest sole leather down to the most delicate glove kid, it was seen

that although admirably adapted for some purposes, sulphide of sodium was not a good substitute for arsenic in all cases. These tests brought out the specific properties of both materials, and thus showed us for which grades of leather arsenic and for which sulphide of sodium should be used to obtain best results. Thus we find that sulphide of sodium is used to this day in the manufacture of sole leather and to some extent in the manufacture of upper leather and morocco leathers, for which classes of leather a close fibre and absence of elasticity are required. It is a fact that also some glove kid manufacturers still employ sulphide of sodium, but these are only those manufacturers who strive to turn out large quantities of leather in the shortest possible time, irrespective of quality, and who, therefore, sell for less than their competitors. For this latter class of manufacturers sulphide of sodium is admirably adapted, as it produces a clean grain with a minimum of labor; it matters little to them that the gloves made from their stock often get hard in a comparatively short time. Manufacturers of glove kid who warrant their stock to remain soft for a long time cannot employ sulphide of sodium. In former times the only depilatory known for all grades of leather was ordinary lime. In the course of time qualities were demanded in leather that could not be obtained by depilating with lime alone. The main requisite demanded of a depilatory in our time is that it should depilate evenly and quickly; further, it should thoroughly remove the fine hair and cleanse the grain and skin from dirt, and above all not plump the hide to that extent peculiar to pure lime. It is very important that the time required for liming the hide be shortened for many grades of leather, because lime dissolves considerable hide substance, and, therefore, pure liming will not produce as close and fine a leather as can be made by using some other depilatory. Of all the innumerable depilatories "discovered" and "invented" of late, only two have come to stay, viz., arsenic and sulphide of sodium. Arsenic fulfills all requirements of a depilatory, as above enumerated, if mixed with lime. The active depilatory agent of the mixture

of arsenic and lime consists of several different combinations of lime and sulphide of arsenic. Both the sulphide of arsenic and the lime have lost their specific properties entirely in these combinations. As is the case in all chemical combinations, arsenic sulphide and lime will combine only in definite and fixed proportions. An excess over these proportions of arsenic is without any action on the hide or hair, as it is insoluble. An excess of lime, however, will act as such on the hair and hide. As in practice, where arsenic is employed in combination with lime, there is always an excess of lime. We really have two different depilatories, viz., a combination of arsenic with lime, and pure lime. We have no technical word for this combination of sulphide of arsenic with lime, excepting the Arabian word "Rusma," or a translation of the German and Austrian tanners' word "Gift," designating poison. This combination of sulphide of arsenic and lime has some very peculiar properties, foremost among these being the property of completely eating up the hair in very short time to a pulpy mass. This property gives us the explanation of its extraordinary depilating power. The root of the hair being the softest part of the hair, this depilatory will naturally first dissolve that part, and with this solution the hair will give. The first requisite of a depilatory—quick action—is, therefore, fulfilled by the sulphide of arsenic and lime combination. Sulphide of sodium in this first effect acts identically with sulphide of arsenic and lime. It also eats up the hair in a very short time and causes it to give, in the same time as the latter depilatory. Both depilatories being so very much alike in this respect, it was thought at first that this would also be the case in all other respects, and tanners of glove kid were glad to be able to abandon the poisonous arsenic. But they soon discovered that other properties requisite to a good depilatory for glove kid were wanting in sulphide of sodium. Besides the hair proper, the animal hide is covered with a short down, similar to what is found on the arms and legs of the human body. This down is known to the tanners as fine-hair. In the process of unhair-

ing a large proportion of these fine-hairs are removed by the beamster, providing a proper loosening of these fine-hairs has been accomplished by the depilatory. As the coarse bulbs of the hair are loosened in shorter time than the bulbs of the fine-hair it is often the case that the former give readily on the beam, while the latter are still held very firm, and can be removed only with difficulty or not at all. It is no trick to properly loosen the hair proper, but the fine points of depilating begin with a proper loosening of fine-hair, and it is here that the tanner must be guided by experience and practical tests to know when the depilatory has accomplished this result. With lime alone the fine-hair may be removed, but pure liming will accomplish this only after the soft parts of the grain and hide have also been dissolved. To properly remove the fine-hair by pure liming without the aid of other depilatories, we would have to employ a large excess of lime and also lime considerably longer. This would not only loosen the hide too much, making it spongy, but the grain would be deprived of its gloss and toughness by the removal of its most juicy constituents. It is, therefore, necessary to loosen the fine-hair by employing some substance in combination with lime that will loosen these finer-hairs in a short time and which will not materially attack the hide. Such a substance we have in the combination of lime and sulphide of arsenic. Without dissolving the soft parts of the hide and without disturbing the structure of the hide the arsenic-lime acts as a powerful solvent on the bulbs of the hair and fine-hair, thus loosening them in a very short time. The rapidity of this action is clearly seen by painting the skins with a paste of arsenic-lime; such skins will unhair clean in as many hours as it would take days to do the work by liming with pure lime. By this painting process, however, we employ the arsenic-lime in such concentrated state as would not be possible without injury to the hide in the limes. Besides, the object of liming is not only to remove the hair, but also to bring about a certain loosening of the hide, which latter cannot be accomplished by the arsenic-lime, but is done by the lime alone. Considering

that the lime must be allowed a certain length of time to bring about a proper loosening of the hide—eight to twelve days—we must correspondingly reduce the amount of arsenic-lime which is added to the limes. While we need about nine pounds of arsenic together with enough lime to form a paste in unhairing by the painting process, we take only about two and one-half pounds of arsenic for unhairing in the limes for about 1,000 medium lambskins. These two and one-quarter pounds of arsenic are sufficient to bring about a thorough loosening of the hair and fine-hair in the limes in about eight to twelve days. Of course if we have particularly heavy, dry skins the quantity of arsenic may be increased about half, while on very small delicate skins the amount should be reduced. We should never use much above the requisite quantity of either arsenic or lime, *i. e.*, only enough of each to thoroughly do the required work. It is decidedly wrong to believe that an excess of lime or arsenic will not harm, for a large excess will inevitably destroy the life of the skin.

Comparing results obtained by arsenic with those obtained by sulphide of sodium, both are almost identical as regards the removal of the hair proper, but in regard to the loosening of the fine-hair there is a big difference in favor of the arsenic. Practical experience has shown that skins unhaired in limes strengthened with sulphide of sodium are with difficulty cleansed of their fine hair. If we are bound to employ sulphide of sodium in the limes we must take considerably more lime than where arsenic is used, or else we must take the chances of injuring the grain by the hard work necessary on the beam to remove the fine-hair.

In cleansing skins and hides from foreign matter the skin or hide has always been regarded as a unit, *i. e.*, grain and hide substance has been regarded as one. Careful observation shows us that this is not correct; the study of the difference in results obtained with sulphide of sodium and arsenic especially throws considerable light on this subject. The animal hide consists of several dissimilar parts.

The hide is made up of the fibro-cellular tissue, or soft albuminous part, the muscular fibres, the grain, and the epidermis.

The epidermis, or extreme outer layer of the hide, is again subdivided into the soft mucous part and the hard horny part.

The epidermis may be regarded as a cast-off part of the hide, which we need not here consider.

The grain of the hide is of a compact, fine and firm structure, while the true skin itself is softer, looser and coarser in structure. It is, therefore, possible to properly loosen the true skin by the action of the depilatory, while the grain will not be sufficiently softened and cleansed. The contrary may, however, also be accomplished; some depilatories will soften and cleanse the grain in comparatively short time, while the true skin itself will not be sufficiently loosened in this time. It is of frequent occurrence that leather is spongy, loose and rotten below the grain, while the grain is healthy and strong. This generally results from very strong pure liming, the grain having resisted the action of the lime longer than the softer true skin. On the other hand, we also often come across leather of which the inner parts are hard and brittle while the grain is sound. This inner rottenness is due to the insufficiently dissolved dirt; it is well known that hard rigid leather generally has the most handsome, bright grain. This latter case is the result of insufficient soaking, insufficient lime, and often partly due to too short liming. If the quantity of arsenic-lime has been sufficient, it thoroughly cleanses the grain. Particularly evident is this difference of structure of grain and true skin manifested by the action of a putrid lime. Here we can readily see that round, putrid spots varying in size are formed on the flesh side, while the grain shows no symptoms of putrefaction yet. If the process of putrefaction be at this moment interrupted by addition of fresh lime, for instance, the resulting leather would be damaged inside, while the grain would be firm and sound. As a rule, however, such putrefaction in the lime is not interrupted in time, because if a tanner is so ignorant as to allow his limes to become putrid, he will certainly not have sufficient sense

to notice the damage to his stock in time to prevent serious trouble.

If the putrefaction is allowed to progress, it will ultimately also injure the grain, which will become manifest by the glossy-looking spot which can be punctured by thrusting a finger through it as easily as through glue size. We recently came into a beam-house where every fifth or sixth skin was so damaged by putrid lime. What are putrid limes—perhaps if they are a year old? Yes, certainly. But a fresh lime can certainly not be putrid. That depends. If the fresh lime is made up with half of the old putrid lime liquor, as is often done, then this so-called "fresh lime" can cause putrid spots on the skins. We give these facts on putrid limes simply to show that there exists quite a difference between the grain and the hide proper in their property of resisting the action of different agents.

It will pay to select in the beam-house such skins as are wanted for fancy colors, and to work them out well on the slating table before tanning. There would possibly be traces of lime fat or dirt in the skins if not properly slated, which would cause spotty grain. The lime forms with the fat a lime soap, insoluble in water, which can be removed only by slating and cannot be washed out. This, remaining in the skins, would be of no detriment as far as a dull or kangaroo finish is concerned, but would show up badly in glazing or fancy colors.

F. E. Atteaux & Co., Boston, Mass., handle sodium sulphide in large quantities and would send full directions for its use on all kinds of hides and skins on application.

DEPILATING WITH CHARCOAL.

In lieu of lime for removing the hair and cleansing the pores, charcoal, which is very cheap in parts of the country where wood alcohol is made, may be employed either as a substitute for lime, or the hides or skins may be, as heretofore, first partly treated with lime and finally treated with charcoal.

The carbonaceous matter employed may be either animal, vegetable or mineral charcoal in suspension, and it is claimed

by William Anderson, of Inverkeithing, near Edinburgh, Scotland, that the results of this treatment are that the hairs are loosened, the pores of the skins or hides purified, and the putrescent matter, grease and other impurities removed.

Mr. Anderson states that the most advantageous method of carrying this invention into effect is as follows: The hides or skins are placed in water of 60° F., with powdered wood charcoal sufficient to give it the consistence of cream, the hides or skins being removed and then placed back in the same liquor each day until the hairs are sufficiently loosened to yield easily, care being observed to stir the charcoal powder which may have subsided in the intervals of removal, in order as far as possible to keep it in suspension.

The hides or skins are afterward washed, fleshed and scudded as in the ordinary method, when they are ready for tanning without other treatment, and the charcoal powder may from time to time be revivified by drying it in thin layers in the sun or in a current of air.

In order to render them flat and soft, and to remove lime and other impurities from hides or skins which may have been treated with lime for the purpose of removing the hairs, the process which has just been described may be applied.

DIPILATING WITH SULPHIDE OF BARIUM.

Foley invented the following process for treating hides and skins previous to tanning, and it relates to removing the hair and epidermis from hides and skins of every description, and, however cured, softening dried and cured hides and skins, and separating the wool and hair from skins in their natural state.

For unhairing he uses, instead of lime, but in a somewhat similar manner, solutions of sulphide of barium of varying strengths, prepared by dissolving in water solid sulphide of barium, produced by heating fine ground sulphate of baryta mixed with carbonaceous substances to about a white heat in a reverberatory furnace or other suitable appliance.

In treating green slaughter hides and skins to remove the

hair and epidermis, first wash them to remove the blood and dirt, and then immerse them in a strong solution of sulphide of barium, about 15° Baumé, for about three to six hours. They are then withdrawn, again washed and taken to the beam-house, to be treated in the usnal manner.

In the treatment of salted or cured hides and skins for the removal of the hair and epidermis, first immerse them about ten to twelve hours in an old or partially spent solution of sulphide of barium, for the purpose of cleansing them and destroying the effect of the salt or substance with which they were cured, and afterward immerse them in a solution of sulphide of barium of about 6° to 8° Baumé for about ten hours, when they are ready for the usual treatment in the beam-house.

In the treatment of dried or flint hides and skins it is necessary, before the hair and epidermis can be removed, to soften them; this is done by soaking them about twenty-four hours in a solution of sulphide of barium that has already been used for unhairing, or in a weak solution of about 3° Baumé.

After the dried hides and skins are thoroughly softened in all their parts, in the manner above set forth, immerse them, for the purpose of removing the hair, and epidermis, in a solution of sulphide of barium of about 5° Baumé for about six hours, and then pass them on to the beam-work.

In the treatment of skins for the removal of wool and hair, apply on the flesh side of the skins, by any suitable means, a concentrated solution of sulphide of barium mixed with any inert substance, to the consistency of thin paste. The solution applied in this manner penetrates the skin, loosens the roots of the wool or hair, and allows it to be removed uninjured and in its natural condition.

This invention has advantages over the liming process now in use for removing hair from hides and skins and softening them, and among others the following are claimed by the inventor: No part of the gelatinous tissue, grain, or substance of the hide is removed or disturbed; hides and skins are left in their natural state and suppleness; at least twenty-five per cent.

greater weight of leather can be obtained from hides treated by this invention than by the old process of liming. The hair, it is claimed, is removed in one-twentieth part of the time usually employed, thus effecting a great saving in time, labor and expense. Hides and skins treated by this invention, and intended for upper leather, do not require to go through the operation of "bating," which effects another saving in time and expense.

WORKING-OUT AND UNHAIRING ALL KINDS OF HIDES AND SKINS WITHOUT LIMES, BATE, DRENCH OR BEAMING.

This is the Peirson-Moor process, which has been carefully and thoroughly tested and developed during the past three years by the North Star Tannage Co., manufacturers of glazed kid and other leathers, Philadelphia, who will doubtless testify to its value and economy.

It is claimed for this process that the unhairing can be done in twenty-four hours at about one-half the present cost, without risk or damage to the hide or skin.

Stone, Timlow & Co., Warren St., New York, control the patent, which is dated February 18, 1896.

There are many other substances which have been used for depilating, which need not here be mentioned.

CHEMISTRY OF DEPILATORIES.*

A sample of liquor from an old, well-plunged lime pit in a tanyard was found after filtration through sand to have a specific gravity of 1.0046 at 17.5° C., and showed a feeble reaction for albumin. The total nitrogen was determined in 100 Cc. by the Kjeldahl method, and the difference between this value and the nitrogen found in the total solid residue was regarded as the nitrogen in the volatile bases. To avoid destruction of nitrogenous matter during evaporation, sodium bicarbonate was added in quantity sufficient to carbonate the lime in the liquor. The albuminoids were precipitated by feebly acidifying with acetic

* By J. Von Schroeder and W. Schmidt-Dumont, in Dingler's Polytechnic Journal.

acid and warming. Volatile acids were distilled in steam after acidifying the liquor with sulphuric acid. Estimation of caustic lime proved difficult on account of the organic matter present. Analysis of the sediment which settled from the liquor before it was filtered gave the following figures: $CaCO_3$, 8.22; CaO, 43.99; CaO combined with organic matter, 8.82; and organic matter, 38.97 per cent.

Since this contained so much free lime it was concluded that the liquor was saturated with free lime, in which case it would contain 1.299 grms. per litre at 15° C. When shaken with lime, however, the filtered liquor dissolved a considerable quantity, showing that lime had been lost during the filtration through sand.

The following table gives the results of the analysis:

	Grms. per Litre.
Organic solid matter	11.856
Inorganic matter	3.158
Containing CaO*	2.010
" MgO	0.013
" alkali sulphates and chlorides	1.130
Total nitrogen	1.649
Comprising N in solid residues	1.527
" N in volatile bases	0.122
Total precipitate by acetic acid	2.022
Comprising fatty acids	0.044
" ash	0.002
" albuminoids (14.21 per cent. N)	1.976
Nitrogen in filtrate from acetic acid precipitate	1.376
Volatile acids (as acetic acid)	0.480
Organic matter not precipitated by acetic acid (containing 13.41 per cent. N)	9.354

*After having been shaken with lime the liquor contained:

	Grms. per Litre.
Free CaO	1.299
Combined CaO	1.678
Total	2.977

The volatile bases present had the odor of trimethylamine and the volatile acids that of caproic acid. The authors do not think that they have sufficient evidence to enable them to pronounce upon the nature of the albuminous organic matter.

Experiments here described in which lime and sodium sulphide were together dissolved in water led to the conclusion that each of these two compounds retains its individuality when in solution in the presence of the other; hence it may be deduced that the simultaneous application of lime and sodium sulphide for unhairing, whether in the form of a solution or of a paste, is beneficial, because each exerts its specific action on hide and hair, not because there is a formation of caustic soda by double decomposition, as has been supposed. The lime probably also serves to protect the sodium sulphide from decomposition by any carbon dioxide which may be absorbed.

For the proximate analysis of red arsenic, the authors recommend that the arsenious oxide should be extracted from 20 grms. of the sample by digestion at a gentle heat with 200 c. c. of hydrochloric acid (5 per cent.) for 5 hours. The solution may then be oxidized by nitric acid and evaporated to dryness, the residue being heated at 400° C. for 45 minutes and weighed as arsenic anhydride. To separate As_2S_3 from As_2S_2, 10 grms. of the portion from which the As_2O_3 has been extracted may be shaken at the ordinary temperature with 200 c. c. of ammonia (2 per cent.) until no more arsenic is dissolved; an aliquot portion of the solution is evaporated to dryness and the As_2S_3 weighed. A sample of red arsenic thus examined gave: As_2S_3, 73.56 per cent.; As_2S_2, 26.11 per cent.; As_2O_3, 0.37 per cent.

To investigate the part played by red arsenic in the mixture of it with lime which is commonly used as a depilatory, 40 grms. of lime and 8 grms. of red arsenic were made into a thin magma with 160 c. c. of water, this magma was heated on the water bath for one hour, then made up to a volume of 3150 c. c. with water, filtered, and the solution analyzed. It was found that 4.13 per cent. of the arsenic, 93.50 per cent. of the sulphur, and 15.25 per cent. of the lime remained in solution. The undissolved residue was brown from the presence of uncombined arsenic, so that the chief reactions may be represented by the equations:

$$(1)\ 3As_2S_2+9CaO+3H_2O=2Ca_3(AsO_3)_2+3Ca(SH)_2+As_2$$
$$(2)\ 2As_2S_3+9CaO+3H_2O=2Ca_3(AsO_3)_2+3Ca(SH)_2$$

There is, however, the dissolved arsenic to be accounted for, since calcium arsenite was found to be quite insoluble even in presence of excess of lime. Experiments showed that calcium arsenite reacts with a solution of calcium hydrosulphide, with formation of calcium thioarsenite which passes into solution. Supposing the arsenic to exist in this form in the unhairing liquor, it may be calculated from the foregoing figures that one litre of the liquor contains 4.355 grms. of $Ca_2(AsS_3)_2$, 27.780 grms. of $Ca(SH)_2$ and 1.299 grms. of CaO. It appears then that the sole constituents of the lime and red arsenic depilatory, which can be considered as active, are the calcium hydrosulphide and the small proportion of calcium thioarsenite, unless, indeed, ammonia and amines developed during the sojourn of the hide in the mixture can dissolve any of the calcium arsenite. This point was settled in the negative by the analysis of a liquor which had been used for three weeks for treating kips, when it was found to contain somewhat less arsenic than it did originally, showing that the amines and ammonia which were undoubtedly present had not rendered the arsenic compounds more soluble. The putrid odor of this arsenical lime liquor seems to contradict the common statement that the function of the arsenic is that of an antiseptic.

It remained to ascertain whether the calcium thioarsenite possesses any depilatory properties. For this purpose arsenious sulphide was dissolved in calcium hydrosulphide solution. In this solution, containing $CaS.As_2S_3$, pieces of raw hide were immersed and kept in stoppered vessels for about a month; none of the pieces were materially altered except that each was colored yellow throughout; the hair was as firm as before immersion, and the hide as soft and elastic. When exposed to the air the pieces lost their yellow color, consequent on the decomposition of the thioarsenite, and at the same time the hair was loosened. The same effect was observed in the case of pieces of hide left in the thioarsenite solution in open ves-

sels. There was depilatory action, but it was found to be due to calcium hydrosulphide, for the arsenic had all separated as sulphide and the solution contained $Ca(SH)_2$.

The authors conclude that the activity of arsenical limes is due to calcium hydrosulphide and calcium hydroxide alone.

DEPILATION BY SWEATING.

Villon claims to have traced the loosening of the hair in the sweating process to the putrefactive action of a specific bacterium which he styles the *bacterie pilline*. This organism is aerobic and feeds upon the hair substance (pilline), converting it into leucine, tyrosine, butyric acid, margaric acid, and ammonia; the ammonia dissolves the coriin and thus swells the hide. Villon further claims he has obtained pure cultures of this bacterium on ammoniacal gelatin—ammonia having an inhibitory effect upon other bacteria—and to have inoculated sterilized hide therewith, when an evolution of ammonia and loosening of the hair followed.

The experiments on which Villon bases his conclusions have been criticised on the ground that the method adopted for obtaining antiseptic conditions was not sufficiently drastic. Sterilization of hide by exposure to a temperature of 50° C. for 24 hours, followed by ten minutes at 110° C. (the method adopted by Villon), was found to be impossible. Recourse was therefore had to the use of antiseptics, and carbon bisulphide in the form of potassium ethyl dithiocarbonate (potassium xanthogenate), was employed as being easily removed by washing, and not deleterious to the hide.

The following conclusions are drawn: A dilute solution (1—0.25 per cent.), of potassium xanthogenate will gradually kill all micro-organisms existing in hide from which the hair has not been removed, without changing the hide to a perceptible extent, even after half a year's immersion. A short exposure (24–48 hours) to this antiseptic will prevent general putrefaction, but will not destroy a streptococcus which by decomposing the *rete malpighii*, loosens the hair. The organisms

which remain active in this way evolve ammonia without any marked quantity of other odoriferous compounds, and are apparently killed, before there has been any attack on the hide fibre, by the decomposition products of the rete malpighii cells. The identity of these micro-organisms with a known form remains to be proved: so far, a tendency of the colonies to develop in the form of an intricate and extensive network seems to characterize this streptococcus.

It is proposed that, in the very probable event of the pure culture of the bacterium which is responsible for the loosening of the hair in the sweating process being obtained, a rational system of sterilizing the hide by carbon bisulphide vapor and then inoculating it with the necessary bacterium shall be followed by the tanner who unhairs by sweating.

In the preliminary preparation of sole leather we use the "cold-sweat" process, while in Great Britain and other portions of Europe, the warm-sweat method is employed; but for the production of upper leather, the hides are limed about as we do.

Dry flint hides are the ones that are usually prepared in this country by the employment of the sweating process for depilating, and it is highly essential that the hides should be properly soaked, and all their parts be thoroughly softened before they are subjected to the sweating process, for if not intelligently prepared, they harden in spots, forming "old grain."

"Frieze" is principally caused during the process of sweating when the grain of the hide is inclined to be tender and has the appearance of being scraped off. "Black spots" or "old grain" are blotches of dark color, and when the hide is tanned, rolled hard, and finished these spots cannot be buffed off, and sometimes they extend over the whole side of leather, as has been stated in the chapter treating of the soaking and softening of hides.

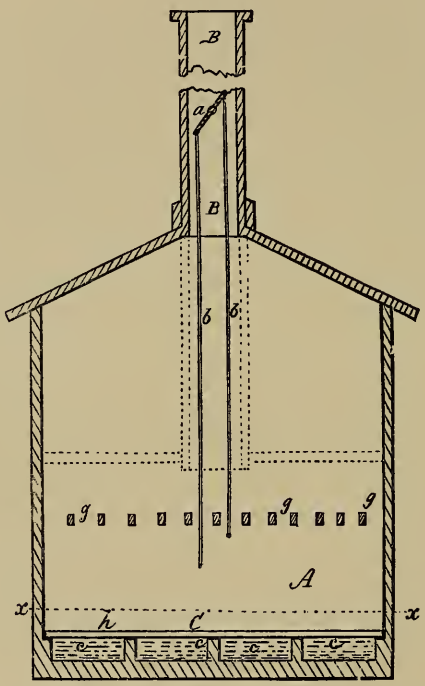
A BUILDING FOR SWEATING HIDES OR SKINS.

The arrangement shown in Figs. 18, 19, and 20 for sweating hides and skins, is the invention of Mr. William M. Mason, of

Buffalo, N. Y., and the valuable points which it contains will be readily appreciated by tanners who employ the process of sweating.

Fig. 18 is a sectional elevation of a building embodying the improvements. Fig. 19 is a horizontal section in line *x x*. Fig. 20 is a vertical section at right angles to Fig. 19.

FIG. 18.

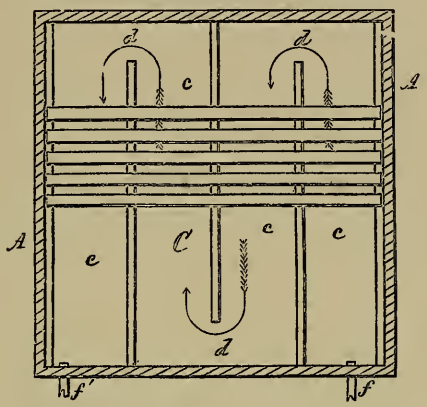


This invention consists of a vault or apartment having a ventilator provided with a regulating valve, and a water-floor consisting of a series of communicating-troughs, arranged and operating as hereafter described, for the purpose of softening dry hides and sweating the same.

In the drawings, *A* represents a building of any kind, and *B* is a ventilator at the top. If the whole building is used as the vault, the ventilator simply extends from the top, as in black

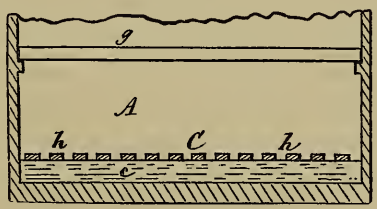
lines, Fig. 18, but, if only one story is used, the ventilator is extended below and passed through the flooring, as shown by the dotted lines, thereby leaving the upper story or stories free for other uses. A valve, *a*, is preferably hung in the ventilator

Fig. 19.



at any point, and provided with cords *b b*, by which it is operated. The use of the valve is to graduate the escape of the current from the interior, by closing more or less of the ventilator space. Any desired number of the ventilators may be used,

Fig. 20.



and they may be extended to any desired height, the latter being preferable as it produces an active ventilation. A water-floor, *C*, is employed, to which is applied water to produce the evaporation. The inventor prefers the form shown, which consists of a series of troughs or water-ways, *c c c*, open at alternate ends, as shown at *d d*, so as to form a zigzag water

communication around, as indicated by the arrows in Fig. 19. The water enters by an induction-pipe, *f*, at one end, and escapes by the eduction-pipe, *f'*, at the other end. This current or flow of the water is essential to discharge such gases as are absorbed by the water and keep the water pure. Either fresh or salt water may be employed; but the latter is preferable, especially in hot weather, as it produces a colder atmosphere, and the salt acts as a preservative to the hides in sweating. A different arrangement of the water-floor and its troughs may be used, and the throwing or spraying of the water on the floor might be used with a similar effect. *g g g* are the slats or poles for hanging the hides. *h h h* are slats laid as a flooring over the water-troughs, with interstices left between to allow of the evaporation.

By the means above described, there is produced cold sweating in contradistinction to the warm sweating heretofore practised. By so doing, it is claimed that the requisite dampness is always obtained without any danger of heating and spoiling the hides. The ammonia and gases are all carried off as fast as they are generated, thus removing at once the great cause of putrefaction. There is, consequently, no loss of the hides from this source, and but little care or time is necessary in conducting the operation, as compared with the usual method.

Any arrangement of doors, windows, or other apertures or entrances may be used, and the vault may be so arranged that an opening may be made in the same at the bottom at any time, for the purpose of admitting air to assist the ventilating action when the atmosphere is heavy, as is sometimes the case.

CARE TO BE OBSERVED IN SWEATING HIDES.

Some tanners prefer to maintain the temperature for the sweating pits at from 60° to 70° F.; but the risk increases largely in proportion to the increase of temperature.

Faithful attention should be paid to the hides during the advanced stage of sweating, and when any give indications of advancing too rapidly they should be removed to the bottom of the pit and properly cared for.

When the sweating process is used for small hides or kips, they should be thoroughly washed in very clean water, spread out after four days' soaking, well rinsed and drained, then laid together in packs in such a manner that the hair is outward, and the pairs of skins back to back. Hang them over the poles of the sweating pit, with the tail end upon the one side, and the head on the other. Then close the door and stop it up well so that the air may be excluded as much as possible, and leave matters thus until the odor of the sweating process becomes quite strong, which is an indication that the process of depilation is about to begin, and from this time out the greatest attention should be paid to the stock.

The working of the sweating process is shown by a sharp lye which forms under the hair, and which drops off the instant fermentation sets in.

Light hides should not be placed in too strong lime; these hides should rather be operated upon by degrees and always with weak lime, after coming from the sweating vault.

The sweating process regulates and hastens the expansion of the hide, opens the pores, and places the hide in a state similar to that in which it was at the time the animal was slaughtered. To prepare it for the leather dressing process, it will be found enough to work the hide lightly on the flesh side with the iron, when it is taken out of the sweating vat, so as to stretch out the wrinkles that may appear before the hide is placed in the lime-pit, which, as has been said, should always first contain a weakened lime-bath.

With regard to the large hides, such as those imported from South America and elsewhere, we urgently recommend that they should be subjected to the sweating process, for, we repeat it, the sweating system has not only the effect of facilitating the process of depilation, but of giving to dry wild hides that development of which they stand in need.

Buenos Ayres hides are a species of hide which softens easily and in a regular manner. It is admitted that hides which are allowed to remain continuously in water soften less readily than

those which are alternately soaked and piled. And now let us consider how piling compares with sweating. Piling is nothing more nor less than a slow inward sweating, and while it is slow you run the risk of having the edges damaged, by giving the time necessary to effect a good result. So in order to save the back and extremities you are obliged to dispense with a complete softening of the hide, and moreover lose time, which is always the result of irregular soaking. We seek to attain in soaking the hide the raising up of the fibres, in order to save those parts of the hide which were wet, and became dried during transportation; and the best mode of doing this consists in accelerating the operation, so as to obtain a thorough soaking by the sacrifice of from seven to eight days.

Stagnant water does not give the dry hide time to become completely softened again, at least it injures the grain, which becomes lost before the water has had time to penetrate the fibres of the hide.

Under these circumstances, sweating is alone of use, and if necessary, a softening during twenty-four hours in open water will be sufficient to secure a satisfactory result, as experiment has proven.

Soak the hides in water for twenty-four hours, mark the flesh side well, and rinse the hair side thoroughly, so as to rid it of all foreign substances, so that no faulty spots may ensue; let them drain in a heap during four or five hours, and bring them to the sweating process as above described. Sprinkle them with fresh water from a gardener's watering pot, provided with a sieve-like spout, and after the hides have been again allowed to drain off, put them back in the sweating vat.

Three sprinklings with the watering-pot will be found ample, in combination with the sweating process, to soften the driest and oldest hides to such a degree that, even if they are of the heaviest, they can at once be divested of the hair. Then separate them after rinsing, lay them again in water, clean and scrape them, and do not interrupt the gradual course which the hide has to undergo.

What we have last above stated should only be resorted to when suitable water is wanting for proper soaking, for we recommend above all things that the hide be carefully soaked in water, as this raises it well; but in all cases, whichever mode of soaking be followed, the hides should never, as a general rule, be allowed to stay in the water longer than four days, or from five to six days in severely cold weather. Of course the sprinkling with a watering-pot is then superfluous, and there will then only remain the placing of the hides in the sweating vat to be attended to. They should be left in it from four to six days, according to the season of the year.

The operation of the sweating process is decomposition, which causes the grain to lose its elasticity, or holding power over the hair, so that it may slip off almost involuntarily, leaving the pelt so soft and flabby that even the advocates for this method recommend a lime-bath after, to resuscitate the pelt, or what they call raise it, previous to putting in to tan.

THE WARM SWEATING PROCESS.

The process of warm sweating largely employed in Germany and many other portions of Europe is usually conducted in a buried box of suitable size, from which the air is rigidly excluded. The box has racks firmly attached to the sides, opposite each other, and into which stout notched poles are fitted to receive the hides after they are properly rolled. The cover of the box is usually composed of loose boards, which are convenient for handling in filling or emptying the sweat-box.

After removal from the water and draining off for a few hours, the hides are placed, hair side out, alongside the sweat-box, and the sides folded in towards the back, or the hides are rolled together from the side towards the back.

If the sweat-box is of sufficient depth, folding in of the head is not necessary, but otherwise it has to be done to prevent the hide from touching the bottom of the box. To keep the head from sliding out, which might easily happen, both ends of the rolled hide are securely tied with twine. After covering the

bottom of the box with a layer of spent tan three or four inches thick, the hides are hung close together over the above-mentioned poles. The box is then tightly covered with boards upon which, to prevent all access of air, tan is piled to the depth of about ten or twelve inches, and well trodden down. Warm steam is frequently used in order to accelerate the sweating process. Though this method offers some advantages, great risk is connected with it, and the utmost care must be exercised to guard against overheating. Spontaneous heat, which is generally developed in five to six days, is always preferable, as it acts more uniformly than heat produced by steam.

After remaining in the sweat-box for a few days, the condition of the hides is examined by removing the tan from one corner and pushing a board far enough back to allow the introduction of the hand. If after examining several hides, it is found that no heat has been developed, and the hair not loosened, the box is immediately closed. With some experience and skill it is an easy matter to determine how long the hides will still have to remain in the box; fourteen days being frequently required before the hair becomes loose. The greatest care and precaution are necessary during the entire sweating process, as putrefaction promoted by heat makes rapid progress, and may cause great loss.

SWEATING FRESH HIDES.

After cutting out the horns, fresh ox hides intended for sole leather are spread out and thoroughly salted upon the flesh side. After folding each hide in the middle from head to tail, and tucking in the shanks, sides, and head, it is formed into a pack; several of these packs are then piled upon one another, and covered with woolen covers or straw. It is best to perform these operations in a cellar.

It is advisable to use three pounds of salt for a large hide, as this quantity is required to protect the flesh side against putrefaction, and besides makes the hides more solid. After twelve to sixteen hours the hides are turned. The packs are taken

apart, the hides refolded, and again piled up and covered, after which they require turning only every three or four days. By this method the hair becomes loose in two to three weeks.

Fresh salted hides are generally not subjected to the sweating process, it being preferred to place them, after thorough soaking in water, in weak lime, when the hair becomes sufficiently loose in from six to eight days to allow of the hides being unhaired.

CHAPTER VIII.

UNHAIRING AND FLESHING BY HAND AND MACHINERY.

In the United States the unhairing and fleshing of hides is done by both machinery and hand; but the hand method is passing away, and it will soon be used only by the small country tanners.

The operations are conducted in the "beam-house," an interior view of which showing the forms of beams employed and other details of the hand method is given in Fig. 21; the German form of beam and stand, used in tawing establishments for skins is shown in Fig. 22, and the unhairing knife in Fig. 23.

After loosening the hair, the hides, if they have been subjected to the sweating process, are removed from the sweating vaults, drawn through fresh water, and allowed to drain. This operation prevents drying, promotes cooling off, and interrupts putrefaction, and as hides thus treated will usually keep for two days without suffering damage, unhairing need not be hurried.

Limed stock is taken from the "limes" directly to the unhairing beams or to the unhairing machines, and is not passed through water as in the case of hides that have been subjected to the sweating process.

The "unhairing" of hides and skins by the hand method is usually effected by placing them upon a beam and scraping the hair off with a concave blade called the "unhairing knife," which agrees with the curvature of the beam, and the operation is performed by men of great physical strength, endurance and skill, acquired only by long and continued application; but this manner is too slow to meet the large and constantly increasing demand for leather, and consequently aids in render-

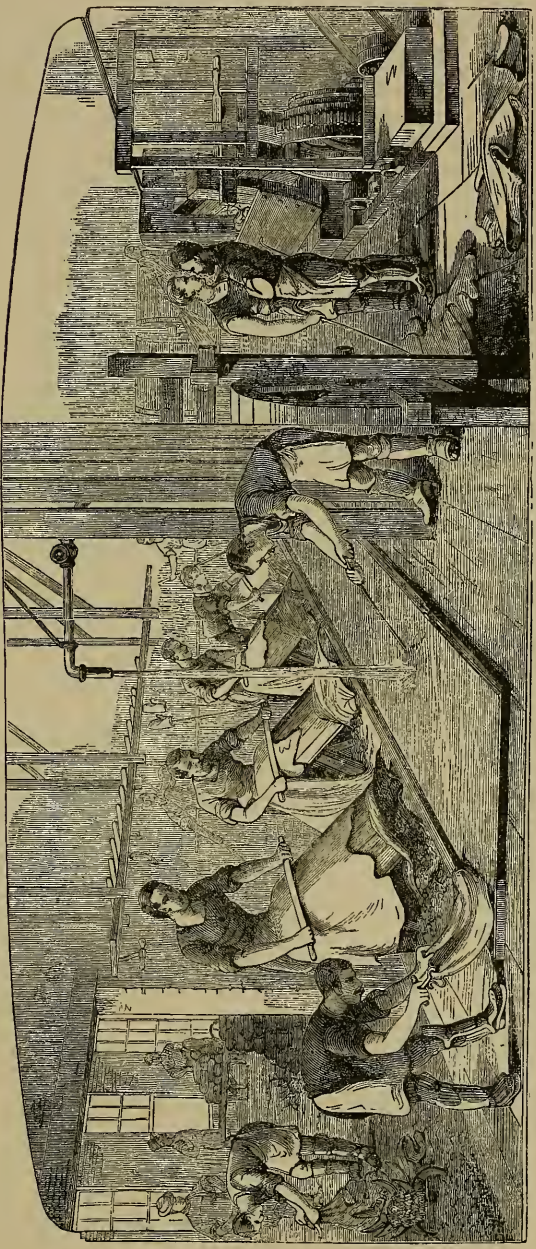


FIG. 21.

INTERIOR VIEW OF A BEAM-HOUSE, SHOWING THE HAND METHOD OF UNHAIRING HIDES.

ing this material too dear for a commodity of such varied and indispensable employments, and in order to facilitate unhairing a large number of machines have been invented in this country; but of this we shall have more to say later on.

FIG. 22.

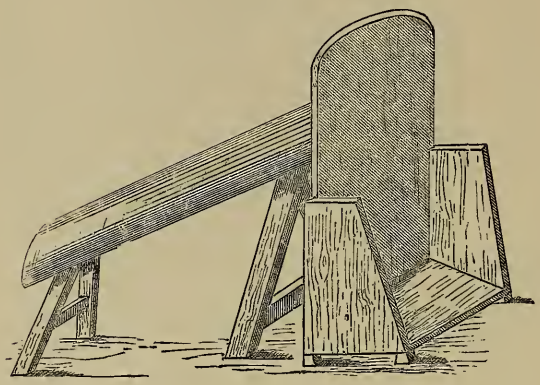


FIG 23.

To offer increased resistance to the tool in the hand process of unhairing, very fine sand, or road dust, mixed with a small quantity of ashes, is sometimes rubbed into the places where the hair is difficult to remove; but this practice is injurious to the grain and should not be employed.

As depilation is more easily accomplished by pushing the knife against the hair, the sides from the hind shank towards the head are first operated upon and then towards the back.

Fresh hides are operated upon as soon as the hair can be pulled out around the shanks, and from the upper part of the head.

After depilation by hand the hides are again placed in water, and rinsed and left to remain over night, after which they are usually ready for fleshing.

In the process of unhairing hides and skins, sometimes some

of them are cut or so injured that they are reduced from the first quality to a lower grade, and thus loss is occasioned. It is well known also that after the hair has been removed by the usual process of liming and scraping or rubbing it off, there remains a short fine hair or fur, and also hair on the edges and extremities of the hide, which has to be removed generally during the scouring by a sharp knife or other instrument called the "short-hair knife." The chief mischief is done to the hides in removing the fine hair by cutting or clipping the grain of the hide, and when this is too frequently done a guard should be attached to the knife in order to prevent the possibility of damaging the skin, especially when it is intended for delicate work.

The knife is made of steel, like ordinary knives, with the usual handle, but for convenience the blade may be made with a double edge, the under side of which is somewhat convex, being thickest in the middle and gradually decreasing in thickness to the edge. The upper side of the blade may have a dovetail rib in the middle or thick part of the blade, and from this rib to the edge on either side the blade should be somewhat concave.

The guard is made with a dovetail groove, so as to slip closely on to the rib. It is made of German silver, brass, copper, or any suitable metal or material, and should project beyond the edge of the blade about the sixteenth part of an inch. Its edges should be thick enough, or slightly corrugated on the inner side, so as to give it requisite stiffness.

When the knife needs sharpening the guard may be easily slipped off and also ground down if necessary.

The concave side of the blade and the openings of the guard allow the hair to pass off without inconvenience.

The knife is used in the same way as the ordinary knife, and is of great value in cleaning kid-skins and other varieties of skins used for glove leather, where so much care has to be exercised to prevent clipping the grain.

In France particular attention is paid to the beam work on

calf skins, and we will describe the process of unhairing and fleshing as practised in that country.

The beam-house is so arranged as to avoid loss of time for the workmen in taking out of the vats and putting back the skins they are working.

They have at least three vats for five or six beam-hands; these vats have a capacity of 375 or 400 gallons each; the water runs into and out of them with rapidity so as to fill and empty them promptly.

The unhairing beams are five feet long, and are covered with strong sheet zinc, and thus have a smooth surface convenient for the work of the operator, and which avoids breaks and knife cuts on the grain side.

The sheet of zinc is 3 ft. 4 in. long and 2 ft. 1 in. wide; the beam presents a convex line of 7½ inches rise. The zinc is fastened with round-headed tacks well nailed down, and must be put about 1¼ inches below the head, for the following reasons: It often happens that it is necessary to put for dripping 35 or 30 skins on the same beam, and to leave them on it for several hours, in which case the undermost hide which rests on the edge of the head of the beam will have a deep curved mark pressed on the neck, and this mark cannot be taken out in tanning or even in currying. The grain at that spot looks like parchment, and refuses to take the tannin. A prominent French tanner tried to discover the origin of these spots, and found that they had been caused by the sharp edge of the beam-head, and he put the zinc about 1¼ inches further down, and from that time he did not find any more of these creases, which had previously spoiled the skins and diminished their value.

The beam for fleshing the skins and for thinning the neck is broader, and less arched than the other; it is lens shaped. This facilitates the work of the knife, for by having a broader surface, the edge is less liable to slip and make flaws, and the work progresses more rapidly, as the operator is not forced to change the position of his calf-skin so often, and when he reduces a throat or a head, he does so in a more uniform manner.

To unhair slaughtered calf-skins fresh from the Paris market, the workman lays two large skins at a time on the beam, and when of medium size places three; but when the calf-skins are small, places four. In order to avoid scratches and to make the action of the knife easier, the workman gives great care to the edge, and leaves no trace of hair upon the skins. He then places them in water, and rinses them.

Next a skillful workman cuts the navels and nipples, trims the rumps, fashions the breeches and the tails, going entirely around the skins, and reaches the neck, which requires special treatment. Should there be any flesh left by the butcher on the flanks and necks, it is lightly removed with the fleshing knife.

FLESHING BY THE HAND METHOD.

This operation, which consists in removing all fleshy and fatty matter by means of a sharp blade, requires great skill. In some tanneries the work is performed with a fleshing knife having a curved blade, which measures about seventeen and a half

FIG. 24.

inches between the handles for the kind used for hides, and about sixteen and a half inches for skins; this form of flesher is shown in Fig. 24.

A workman once accustomed to handling this tool can turn out very clean work, but it is far better to use for this purpose

FIG. 25.

the so-called German fleshing knife, which has a blade measuring from twenty to twenty-three inches between the handles,

and about an inch and three-quarters wide, and which is shown in Fig. 25.

The German, or spring fleshers, are especially recommended for extra clean work; they make a more satisfactory cut than the other styles of fleshers, as the workman is able to readily adjust it to the curved shape of the beam, which is a great advantage, over the stiff straight-edged flesher cutting on an oval or convex surface.

The spring pating fleshers measure about seveteen inches between the handles.

In the commencement of fleshing a hide is laid escutcheon part down over the beam, and shaved the entire width of the beam, and as far down as the workman can reach, this hide, forming a support which is later on replaced by one entirely shaved. The hide to be fleshed next is laid, head down, over the beam, and after shaving it, first the entire width of the beam, and next the sides, it is turned over and finished by shaving the escutcheon. In fleshing the left hand precedes the right, and, to prevent injury to the hide by cutting into it, the

Fig. 26.

workman should accustom himself to drive the knife without stopping, as far as he can reach from the top to the bottom of the beam.

The projecting filaments or shreds, and those parts of the borders of the skin which are thicker than the rest, are cut off with a sharp knife and the portions thus removed are sold to the glue manufacturer.

For the removal of butcher cuts not accomplished by fleshing, the smoothing stone often proves a great advantage.

The saw-toothed flesher sometimes employed for dry hides is shown in Fig. 26.

The turning steels employed are round and three square, sometimes the latter style is file cut on one side. The three square turning steel is shown in Fig. 27.

In the portion of this chapter devoted to the unhairing of calf-skins, the manner of cutting the navels and nipples, and trimming the rumps, etc., of calf-skins was described. Following this operation the flesh sides are gone over with the

FIG. 27.

"worker," the skins being pushed crosswise or diagonally, starting from the humps of the shoulder. Large calf-skins are put on the beam one at a time; but two skins are put at once on the beam if they are of medium size or thin.

In order to have this work done successfully the workman must, by means of short and brisk blows, applied in a kind of mowing fashion, get off by main strength all the fleshy and parchment-like tissues, from the body of the hide and from the sinews of the fore and hind legs.

The action must be brisk and vigorous on the crupper, where the nerve of the hide must be entirely broken; go over lightly on the fore and hind flanks without even trying to take off the tissues with which they are covered; the collar must also be managed carefully; the action must be brisk on the necks and heads if there are any tissues.

In acting in this way the nerves of the hides are completely broken on their sinewy parts, and due consideration is given to the weak or hollow spots.

This work is very important, and must be overlooked with great care, as the skins that are not worked in the way just explained, but which are merely and indiscriminately scraped for flesh, never develop themselves well in tanning, refusing to absorb the tannin and give poor results in the currying.

When all the skins have undergone this process they are put to soak for six hours in a vat of clear water.

Then they are next counter-fleshed, putting two hides at once on the beam; they are again soaked in water for an hour or two; they are takan up and gone over with the "worker," putting two large skins on the beam, or more if they are small; the flesh side to be upwards. It is very important to have this operation well done with the "worker," slight blows at first, then heavier, in order to empty and purify them of lime; then the grain is cleaned with a knife of which the bevel must be very smooth in order to avoid scratches.

After these two operations the hides are put to soak in clean water for three or four hours. They are then taken in hand again and given a last working of the grain *on the body of the hides only;* are rinsed for the last time, and piled awaiting storage in the vats.

It requires a sure hand to do the fleshing of a calf-skin. The work must be done in mowing fashion only, as straight heavy blows are apt to enter the skin and leave marks of cuts. The butchers do generally enough mischief to the skins without the tanners adding any more. It requires then some knowledge and experience to avoid all mishaps; and furthermore the tanner's is a rough trade and it requires a pair of stout, hard and vigorous arms to make a good beam-hand.

SOAKING HIDES AFTER FLESHING BY THE HAND METHOD.

This operation exerts a great influence upon the quality of the leather, and is much more highly esteemed in Germany and France than in this country.

After fleshing, the hides are placed in water as clean and clear as possible, and if running water is used, a location where there is but little current, or none whatever, is chosen. If a river or creek has to be used for the purpose, a pole is driven perpendicularly in the bottom of the river, upon which the hides are successively strung through the ear hole and pushed towards the bottom, care being observed to keep them spread out horizontally. If the water is deep enough as many as twenty hides may be suspended one above the other. To give

a better support to the pole the end projecting above the water is pushed through a strap secured to the bank of the river.

The hides are drawn up twice daily by means of a hook, rinsed off, moved and replaced in the manner described.

SOAKING HIDES IN A STEEPING CISTERN AFTER FLESHING.

In tanneries located on a river or connected with a water conduit, provision is generally made in Germany and France for steeping cisterns, which are of great advantage for the preparation of sole and upper leathers. They are constructed either of stone or wood and so arranged that the water can be admitted and drawn off very rapidly at will.

After fleshing, the hides are placed in the steeping cistern previously filled with fresh water. After 12 hours they are moved, the water is drawn off, and the hides, after the admittance of fresh water, are replaced in the steeping cistern. This operation should be scrupulously repeated twice daily to prevent putrid soaking from making its appearance to the injury of the hides. By putrid soaking, which is recognized by a foul odor of the water, we understand the assumption of a flabby condition by the hides, while on the other hand, with a fresh and sound soaking, they feel firm to the touch and smooth upon the grain side, and the water has no odor whatever.

HOW LONG SHOULD THE HIDES SOAK AFTER FLESHING, AND WHAT INDICATES THEIR READINESS FOR SCOURING?

In this country the hides, after fleshing, are soaked for a much shorter period than in Germany and France. Hides intended for sole leather, with us, are generally allowed to soak over night, while in the countries which have been named, the time for soaking is from three to five days, the period depending much on the temperature of the water, the hides meanwhile being frequently examined as regards their readiness for scouring. They are ready, 1st, when the fine film still adhering on places after fleshing can be readily detached by scraping with the finger nail, and 2d, when by pressing with the fingers upon

the grain side the indented places remain visible. As these indications can be most readily perceived after rinsing, it is well to make these tests after each rinsing operation.

Hides intended for the production of upper leather after being "green shaved" are placed directly in a bate of hen manure and worked sufficiently with a drench wheel, after which for about 5 minutes they are worked in a wash-wheel, and are then worked over with a hide-working machine and are next placed in spring water to soak over night. It is conceded that the bate neutralizes the lime in the hide and leaves this class of leather more pliable than when it is subjected to long soaking in water, which while it will extract the lime imparts an undesirable harshness to upper leather.

FLESHING AND UNHAIRING BY MACHINERY.

The processes of unhairing and fleshing hides as usually performed are the most laborious operations in the business of tanning and require the workman to be constantly in contact with cold, wet hides, which is very injurious to the constitution, subjecting most operators to disease and forcing many to leave the business. The fleshing and unhairing of hides and skins is now successfully performed by machinery at a cost of less than one-third of the hand method.

After the hides have been soaked they are fleshed before they are limed, when machinery is employed, and after the liming they are unhaired, and then refleshed to take off the flesh "puffed up," or raised by liming, or left on after first fleshing. For sole and rough leather the process is the same. A few tanners "green shave," or flesh out of the lime, and do not flesh out of the water soak at all.

In Fig. 28 is shown the Vaughn new heavy construction beam-house machine for fleshing from the soaks, unhairing, refleshing from the limes, green shaving, and working out, or fine hairing, and largely used by tanners of sole, harness, belting, rough, upper or grains, buff, colors, wax, kips or calf.

It will do all these operations perfectly and completely, and

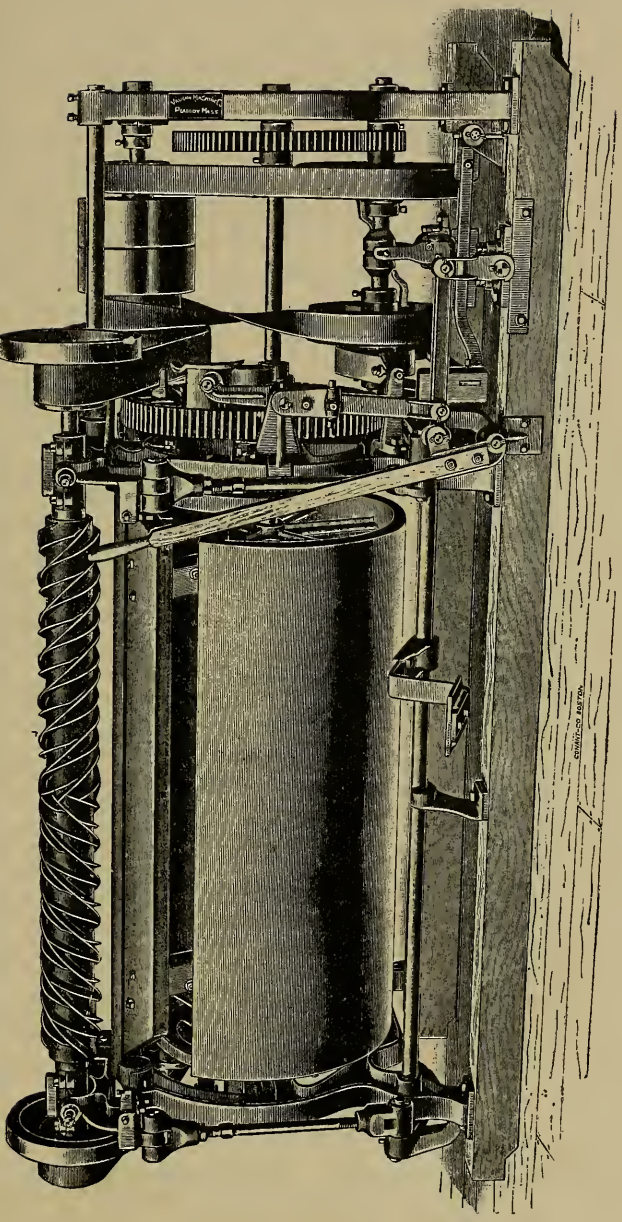


Fig. 28.

VAUGHN IMPROVED FLESHING, UNHAIRING AND WORKING-OUT MACHINE.

the manufacturers guarantee its work to be far superior in every respect to that done by hand or any other machine. They will send them out on trial to any responsible concern, and if the results do not substantiate the above statement, it to be no sale.

Remember, the builders fit each machine for the work it is sent out to do, thereby insuring to every tanner perfect results on his own particular class of stock, in his own particular way of working it. This their long experience in all kinds of tanneries enables them to do to perfection. It is beyond dispute that what would be good work and good results on one kind of stock, would be ruinous on another.

The principle and construction is the best that could possibly have been conceived for the purpose. This fact is conceded by all. The machine and work being at all times under the perfect control and observation of the operator, who sees the hide being worked as the bed carries it through the under cylinder, and then just how it has been done as the bed returns to its place again, thus each and every hide being worked properly and perfectly, and if the desired result is not obtained by once passing through, it is readily seen by the operator, who, by simply moving the lever, causes it to be worked as many times as desired without handling the hide or taking much extra time. This is important, and it is claimed can be done by no other make or style of machine.

The cylinders also are a great and important factor in the success of this machine, and the splendid work and results they give cannot be obtained with any other style or form, as has been proved by their years of service, and the many attempts to equal them. By their peculiar construction, the hide is worked both in length and width at one and the same time, and the hide, lying as it does on the drum or bed, covered with a soft rubber cushion, is subject to no strain or damage whatever on the body, head, flanks or shanks.

The adoption and sole use of this machine in all the leading tanneries of the country, is proof positive of its superiority over hand work, or that of any other machine.

FIG. 29.

HUB FLESHING CYLINDER—FOR FLESHING FROM THE SOAKS AND REFLESHING FROM THE LIMES.

FIG. 30.

SLATING CYLINDER—FOR UNHAIRING AND WOKKING OUT.

One machine is fitted to do the whole beam-house work if desired, so can be used to great profit and advantage by those running small tanneries.

But one operator required.

Economy of space and power.

Both quantity and quality of work obtained.

Will work equally well whole hides, sides, kips and calf.

Sizes or length of cylinders 54 inches, 72 inches, 84 inches, 108 inches.

This machine is built by the Vaughn Machine Company, Peabody, Mass.

The cylinders used with this machine are shown in Figs. 29 and 30.

The success of machinery for working hides, skins or leather depends on the cylinders used, and it will at once be seen by these cuts why the Vaughn machines are so superior to hand work, as by their novel construction the blades are working the stock both lengthways and sideways at the same time.

The builders vary the form and material of them according to the work required for them to do.

Fig. 31 shows a grinding lathe or cylinder and roll sharpening and turning up machine, made by the Vaughn Machine Company, Peabody, Mass.

As will be seen by the cut, this machine works much like an ordinary lathe, excepting the cylinder runs in bearings the same as when at work in the machine (instead of on centres as would be the case in using an ordinary lathe), therefore it is bound to be kept perfectly true for the work in the machine in which it is used.

The builders use this machine for sharpening the cylinders of their machines where the emery dust or grit of the automatic grinder on the machine would be a detriment or cause damage to the stock, as by using this all the above is kept entirely away from the machine and stock being worked.

It is a valuable machine to have where Belt Knife Splitting Machines are used, as it will keep the rubber rolls perfectly true and in fine condition.

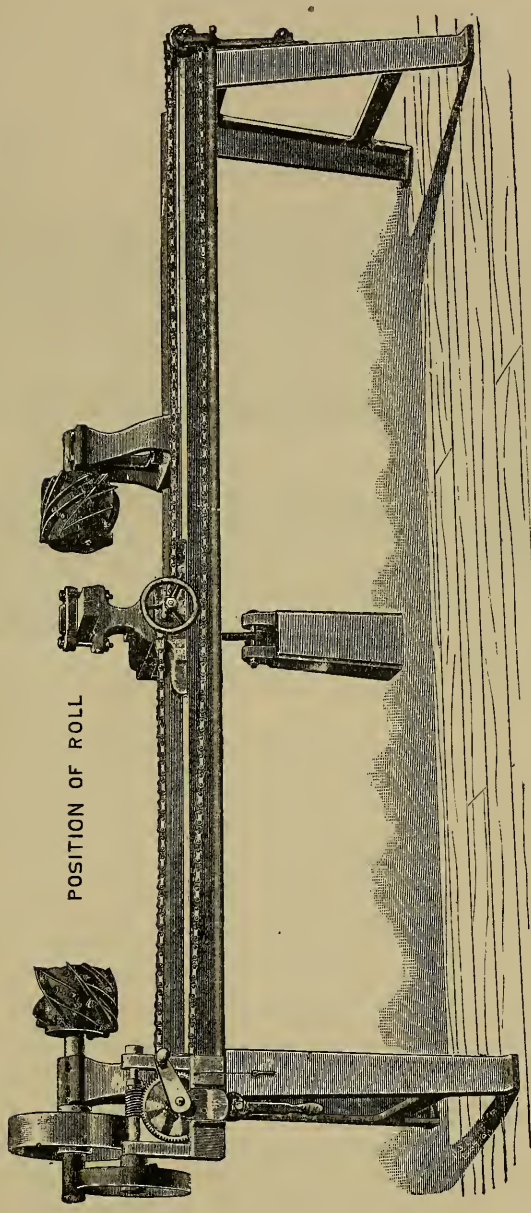
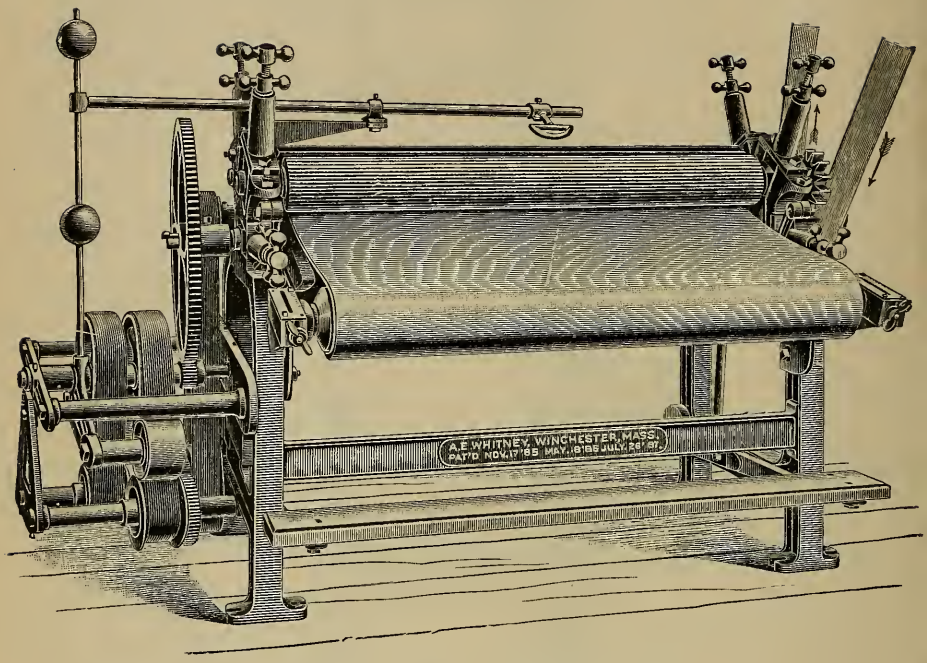


FIG. 31.

GRINDING LATHE OR CYLINDER SHARPENING MACHINE.

UNHAIRING MACHINES.

FIG. 32.



WHITNEY'S "JUMBO" UNHAIRING MACHINE.

Fig. 32 illustrates Whitney's patent double-acting unhairing and hide-working machine. It is made in four sizes: 52 inches, 64 inches, 82 inches, and 109 inches.

This machine (familiarly called "Jumbo,") differs from the original well-known Whitney Unhairing Machine in this respect: it is made to feed the hide both ways, unhairing it when it is feeding into the machine, and working it when it is feeding out, thus effectually cleaning it (especially the shanks and end pieces) at one operation. As no part of the hide jumps through the machine, no part escapes a thorough working.

In operating the machine the hide is laid upon a traveling rubber apron which carries it to the "bite" between the two upper feed rolls, and the apron supported by the lower feed roll,

thence to the work roll filled with slate blades housed at back of machine which revolves against the hide at a high rate of speed, thus thoroughly cleansing it. After the hide has passed half way through the machine, the operator reverses the feed and the hide is fed outwardly into his hands, when he turns it and works the other half in the same way as first half.

It is obvious that particular hides may be worked over several times, or they may be fed right through as in the old-style unhairing machine, and may be left at either front or back of machine when sufficiently worked.

The shipping mechanism is very simple and works without noise or jar. It consists of two loose belts running in opposite directions, which, when alternately tightened, drive the feed gearing. Either belt is tightened by throwing the weighted lever attached to the swinging binder frame to one side or the other off its centre of gravity, the working belt being made sufficiently tight by adjusting the ball weights so as to just throw it over the centre.

The belts are made double and endless, and should be each 57 inches long. If they stretch from use they can be adjusted by lowering the frame to which the binder pulley shafts are attached.

This machine will unhair and work out 75 to 100 sides per hour. It is in use in many tanneries. It takes but a small amount of power. The slate roll is so constructed that it will not cut or scratch the hide in the least, and the slates can be quickly replaced. They are the best quality and not easily broken. Steel bladed work rolls are furnished with the machine in place of slate when so ordered.

This machine is made by the Whitney Machine Co., Winchester, Mass.

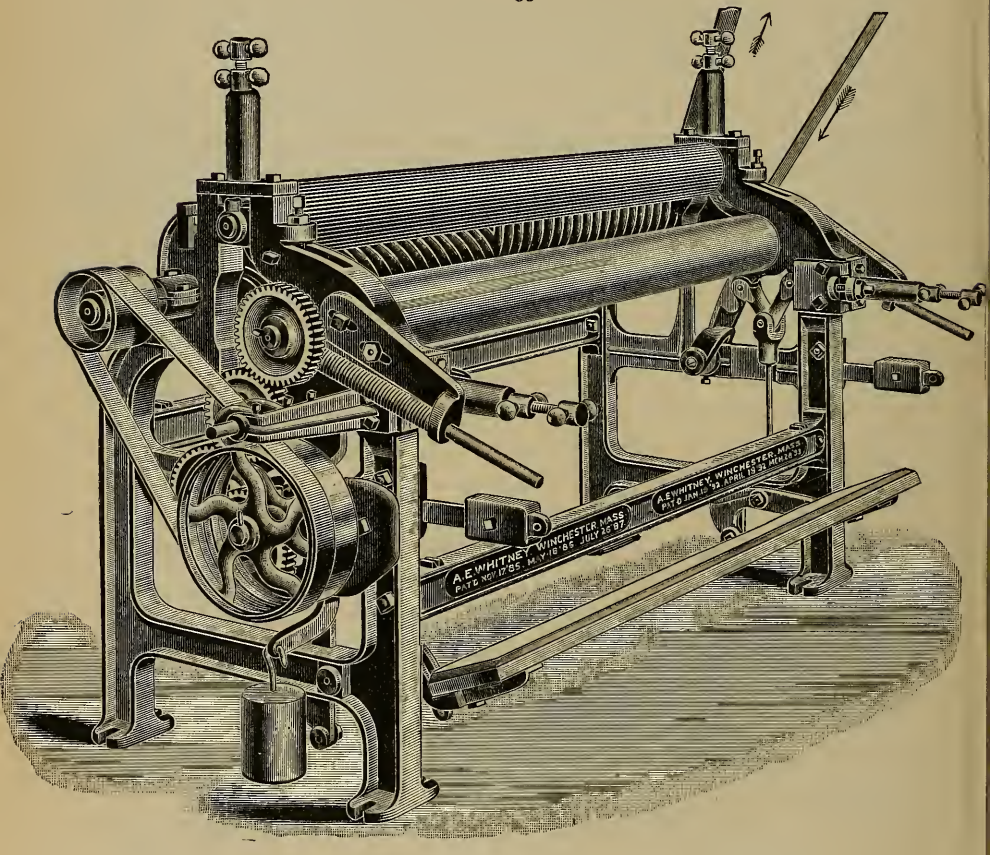
The machine shown in Fig. 33 is particularly adapted for use in small tanneries. It is really three machines in one. It will both flesh, unhair and work out 250 sides per day. It can be adjusted to do different kinds of work by simply taking out the fleshing roll, and substituting an unhairing or a working-

out roll, which operation takes but a few moments. It is perfectly noiseless in its work.

When used for fleshing, this combined machine fleshes the hide in the same manner as the regular fleshing machine.

WHITNEY'S PATENT COMBINED UNHAIRING FLESHING AND WORKING-OUT MACHINE.

FIG. 33.



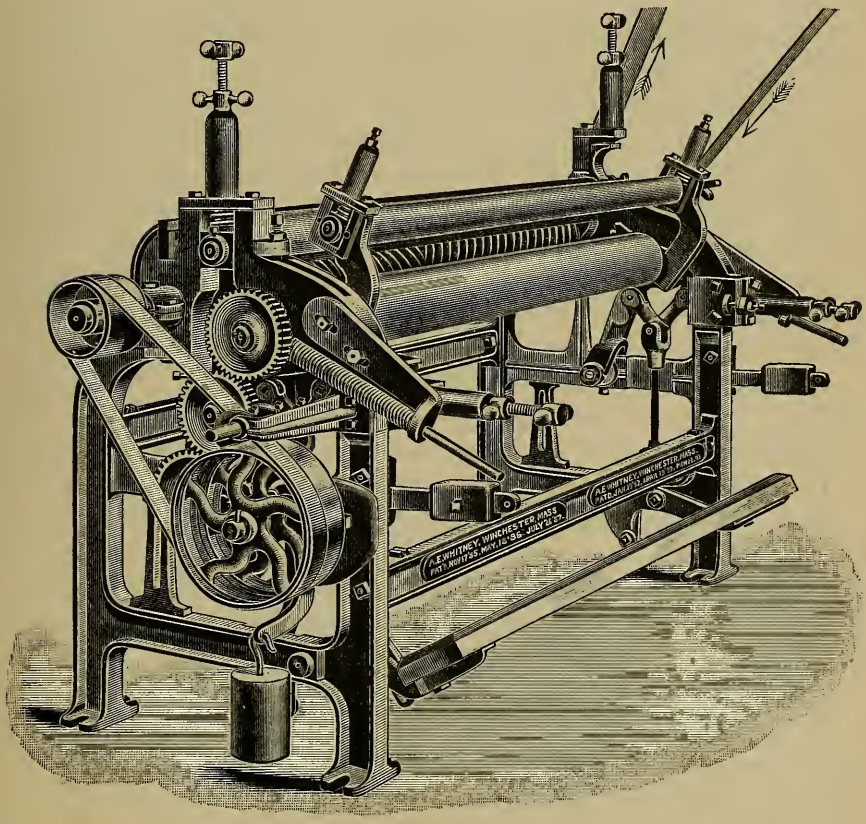
In quantity and quality of work both machines are equal. For economy in the use of power and simplicity of operation, there is no better fleshing machine in the market than the Whitney machine. It has been adopted by many leading tanners.

For unhairing, this machine can be altered so as to feed a hide over a table into the machine from one end to the other without reversing it, the same as hides are fed into the regular unhairing machine.

For "working out," the combined machine is unexcelled. It can be furnished with either of the various kinds of *steel* or *slate working out* rolls, as may be best adapted to the special kind of leather to be produced. Special Slating Rolls are made to order by the Whitney Machine Co., Winchester, Mass.

WHITNEY'S PATENT RE-FLESHING MACHINE.

FIG. 34.



The machine shown in Fig. 34 is made in four sizes: 52 inch, 64 inch, 90 inch and 109 inch, and it is designed to re-flesh, or "cut over," the hide after it has been limed or unhaired and once fleshed out of the water soak. This operation takes off the flesh "puffed up" by liming or left on after the first fleshing. As the hide is in a slippery state, it spreads very easily, and there is no danger of cutting it. The feed rolls are so constructed as not to injure the hide in the least, and yet are so powerfully arranged as to hold and feed the hide without the aid of clamps of any kind.

The operation of re-fleshing saves the tan-liquor, which otherwise would be wasted tanning refuse. Without cutting into the hide in the least, it leaves it so clean as to save the operation of skiving and the expense of maintaining a skiving machine. After re-fleshing, the hide will more quickly take the tan liquor, and a heavier split can be obtained.

The capacity of this machine is from 800 to 1000 sides per day of heavy hides, or from 1400 to 1800 skins. It is easily operated by an ordinary beam-house workman.

In operation, a hide is thrown into the machine over the two front feed rolls (see cut) which are in a state of rest. Foot pressure on the treadle swings the two feed rolls, with the hide upon them, up against the cutter roll, and also binds the hide over a middle feed roll housed in the frame of the machine. Just as the hide comes in contact with the cutter roll, the feed rolls commence to revolve outwardly and pull the hide against the cutter roll and into the operator's hands. After the first half of the hide is re-fleshed, the second half is cleaned in the same manner.

This machine is noisless in operation, simple and substantial in construction. It takes from three to four horse-power to drive it. The cutting cylinder blades are made of the best hardened steel, and are sharpened by a patent grinder attached to the machine.

This machine is built by the Whitney Machine Co., Winchester, Mass.

The craft of the tanner is one which dates from time immemorial, but of recent years great strides have been made in the advancement of the art. New ideas have come to the front, and better leather is now being made and at a lower cost of production than ever before. At present, more attention and thought are being devoted to this department of the trade; competition and the demand for a better and greater variety of leather has made it necessary.

The tanners of the past have been proverbially unprogressive, and it is now only in the face of severe competition and diminishing profits that they are waking up and asking, "What can we do to be saved?" The answer is to economize in every way that it is possible to practice economy.

The tanner of to-day must be alert and constantly on the lookout for new and improved processes and machines and adopt them when found, for it is only in this way that he can keep abreast of the times and make a profit.

There are tanners who still unhair and flesh by hand because the machines they tried years ago for these purposes were crude and unsatisfactory, and they forget that the modern machines are not only successful but decidedly economical in use.

It has been demonstrated that the unhairing and fleshing machines are now a practical success, and in many tanneries the beam men have disappeared, the machines having taken their places, saving to the manufacturer fully two-thirds of the cost of unhairing and fleshing.

Small tanners have an idea that they can not afford to buy beam-house machinery—this is a mistake, as one machine of small size can be purchased which will not only unhair but flesh, work-out, re-flesh or "cut over," and do a great many other desired things by simply changing the roll.

Tanners in small country yards will not long continue to unhair with the knife over the beam—this is not always thoroughly done, particularly in dressing leather which has to go through bates. Men say, "Oh, it will come out in scudding;"

but we would say, unhair them clean, and most of the scud will leave the skin in the first stage, it will pure better, and be less flabby in the offal, and for sole leather it will be better color, and better quality. This should be a great consideration, but it is much overlooked. We regret to know the practice is to get over the work, not how well it may be done.

Unhairing by machinery is a great acquisition, and much more dependence can be placed upon the regularity of the work, and less danger of the grain being injured by cuts and scratches. A great writer truly said English and American workmen are not so painstaking as Continental workmen, but every part of manufacture requires this painstaking, or perfection will not be attained; neglect in any one stage cannot be compensated in the following ones. For instance, if a part of the pelt is not thoroughly softened in the soak, the depilator will harden it, the hair will be difficult to remove, and the tannic acids will not penetrate so as to amalgamate and chemically unite—the leather will be hard and shelly.

Unhairing and fleshing by machinery seem to start the pelt right, it goes through the tanning process right and comes out right in the finishing.

CHAPTER IX.

BATING.

THE operation of immersing hides and skins intended for the manufacture of pliable leathers, in an alkaline solution consisting of the dung of chickens, pigeons, dogs, or in bran water, or in any of the compounds intended to supersede the dung solutions, or to be used in combination with them, is termed either "bating," "abating," "grainering," "reducing," "drenching," or "puring."

The greatest risk in any beam-house is that of bating, mainly for two reasons, either that of over-bating or insufficient bating. The one is as bad as the other, for in either case the leather when tanned will not bring full prices. Because where leather has been underbated, the stock still containing lime is bound to produce hard, brittle and cracky leather, and, if fancy colors are desired, uneven coloring is the result. No stock not thoroughly freed from lime can possibly make good or standard leather. Now, on the other hand, if stock is overbated, the result is loose-grained and spongy leather, which also commands a poor price.

This great risk, which plays so important a part in every tannery, is recognized by all tanners, and many patent bates have been sprung upon the market to live but a short life, for the same trouble was found with them as with the various manures and bran, viz.: that beamsmen could never control the bate, and it kept them in a constant strain of mind as to whether this or that pack would come out right or not.

It does not seem, strange, therefore, that the theory and practice of the beam-house preparation of hides and skins should have remained practically unchanged for centuries.

While chemistry has invaded the domain of so many other industries and wrought wonderful and beneficent improvements, it is only within very recent years that the tanner has been willing to concede that chemistry had anything to do with the art of leather manufacture. It is, nevertheless, true that the whole science and art of tanning rests upon and is dependent upon chemical action and reaction. For this reason many able chemists have within recent times directed their attention to the scientific investigation of the processes connected with the tanner's art, with the result that much has been learned regarding the technology of these processes, and the tanner has been given explanations covering the "why and wherefore" of his methods, which should be invaluable to him in the prosecution of his business. It is a melancholy fact, however, that the tanners as a class are reluctant to countenance new ideas and suggestions which run counter to their preconceived notions, and are prone to cling to the old ways and to belittle the efforts of scientific men, who would help them to a better understanding of their trade and would give them valuable aid in advancing them toward improved methods.

It is a standing disgrace to leather manufacturers that they have for so long a time adhered to the practice of using manure bates for the purpose of removing the lime from hides and skins after they have been unhaired. The use of a manure bate is not only an extremely disgusting operation, but it is also a highly dangerous proceeding, for the hides and skins are more or less liable to injury or damage from the moment they are placed in such a bate. It has been ascertained and proved beyond a doubt that the action of a manure bate is due to an energetic fermentation, producing innumerable bacteria, which eat away, deplete and dissolve the hide substance, and if skins are left long enough in such a bate they will entirely disappear. This fermentation also produces several of the weak organic acids, which together with the ammoniacal salts present in the manure, combine with the lime, forming soluble lime salts that are removed from the skins by subsequent washing and work-

ing on the beam. The same may be said of a bran bate; the fermentation of the bran producing acetic, lactic, butyric, and similar organic acids, which form soluble salts with lime; but these same acids moreover act as solvents of the hide tissue, and the result is the formation of a nidus for the propagation of myriads of bacteria which attack the gelatine of the hide substance. If the operation of manure bating and bran drenching is not carefully watched and properly conducted, serious damage is often encountered which entails irreparable loss to the tanner; this being especially true where skins are intended to be colored and finished on the grain. The "puer run" grain is well known to tanners, and they are only too well acquainted with the discouraging losses they have met with on this account.

It is unnecessary to go into details as to why the lime or other alkaline depilatories should be removed from hides and skins previously to tanning; it being sufficient to say that it is agreed upon all sides that it is a necessity to perform this operation in order to obtain good merchantable leather. Now it is plain that subjecting skins for this purpose to animal putrescent and vegetable fermenting solutions is objectionable, and it is equally evident that a working substitute that would do away with the undesirable features of these solutions would be a veritable blessing to the tanner. There have, of course, been many substitutes proposed and many patents issued to inventors covering processes for bating, but they have all been more or less based upon the idea of producing a ferment that would act upon the skins in much the same manner as the old processes. The attempt has been made to build up by synthesis a substance that would contain the essential elements found by analysis to be contained in the dog, hen and pigeon manure. A compound made of old cheese, sal-ammoniac and glucose has been used. But such preparations all have the defects inherent in fermentive processes. From a purely chemical standpoint a dilute solution of an acid known to form a soluble salt with lime, such as hydrochloric acid, would seem to be all that is required; but in practice it is found that the action of such

mineral acids causes intense swelling, and the hide assumes a transparent, gelatinous appearance, and loses its fibrous character, thereby rendering it unfit to be converted into leather. Nevertheless an acid of some sort is theoretically the proper thing to use; but it must be an acid that will not disturb the fibrous nature of the hide, that will form soluble salts with alkaline bases, and that will not induce nor support fermentation; in other words, such an acid must be antiseptic and preservative in its action, while at the same time it performs all the other functions of a bate. After a long series of investigations and laborious experiments in search of such an acid, Mr. Peter S. Burns and Mr. Chas. S. Hull, of the Massachusetts Institute of Technology, discovered that the naphthalene sulphonic acid possessed all the properties requisite for such an antiseptic bating and puring acid. They applied for and obtained a patent for the use of this material for bating purposes in 1891, and the patent is now owned and the material manufactured and sold under the name of "C. T. Bate" (coal tar bate), by the Martin Dennis Chrome Tannage Co., of Newark, N. J. This "C. T. Bate" has now been long enough in use to have its merits tested most thoroughly, and it has been found to fulfill all the expectations entertained concerning it as the long looked-for substitute for the nasty, offensive and old-time manure bate. In its commercial form the "C. T. Bate" is solid, but it is readily soluble in water. Only a weak solution is required to perform its work as a bate; it is cheap, clean and agreeable to handle, is not poisonous, and the hides coming from the bating solution, ready for the tan liquors, are smooth, soft and white, without having lost any hide substance in the bate, and with the grain intact. Since the introduction of the "C. T. Bate" there have been other acids proposed and claimed to have a similar character for bating purposes. Prominent among these is a mixture of acetic and lactic acids, but these acids do not resist fermentation, but rather promote it; besides, acetic acid is a solvent for gelatine, while lactic acid, according to Fownes, in the presence of water and a ferment like animal membrane produces lactous

fermentation with the formation of butyric acid, which is a powerful solvent of hide substance. Another material under the name of "borol" has been patented in Germany for bating purposes, ascribing to it lime-dissolving and antiseptic properties. It is obtained by melting boracic acid with bisulphates of the metals. In a description of "borol," it is stated that "in an anhydrous state it represents a vitreous mass, which becomes opaque by absorption of humidity; it dissolves readily in water; it tastes and reacts acid, is to a high degree a solvent of lime, and prevents putrefaction." In 1894 a patent was issued to P. Hauff in Germany for the use of sulphonic acid for removing lime from hides and skins, but this was fully anticipated by the patent issued to Burns & Hull in 1891 in the United States. In fact, it looks as though Hauff appropriated the American patent outright, but priority of invention in one country destroys the validity of a patent in another country, and therefore Hauff is not entitled to the discovery of this most valuable material. It is certain that American inventive genius is a long way ahead in discovering and applying new methods in the industrial arts that save both time and labor in production; and it is hoped that this new American process of bating will sooner or later come into general use, to the great advantage and profit of our leather manufacturers.

Bating should always be done in a paddle, as the stirring motion allows the stock to free itself of lime, and never should be done in a stationary tub.

There are a large number of tanners who still stick to the old form of manure bates, and for their benefit we make the following suggestions and offer such substitutes as occur to us:

High-limed goat skins will not stand much pure. Wash skins from lime in water in which a little sal ammoniac (chloride of ammonium) is dissolved; this will remove considerable of the lime; then give them a light pure.

If the problem was merely to remove the lime still remaining in the stock, the operation would be an exceedingly simple one. For example, the stock could be treated to a dilute solution of

some ammoniacal salt such as chloride of ammonia (sal ammoniac). This would remove the lime, leaving the stock white and seemingly clean. Or very dilute muriatic acid would be effective for this purpose. The fermentive action of the bate must be considered its essential property. The skins themselves ferment with the bate, and as considerable gases are developed and become entangled in the skins they rise to the surface of the liquor and are thrown out of the action of the bate. The operation is therefore to some extent automatic, for if they should fall in the bate again, as they sometimes do when a thunder-shower comes up, they would have to undergo a further ferment before raising, and under such circumstances would be over-bated and probably run on the grain.

This fermentive action is of course dangerous.

The ferment developed produces weak organic acids which act upon and dissolve the lime; at the same time the stock is reduced, becomes soft and slippery, the pores are opened so that the dirt, lime, greasy soap, fine hairs, etc., can be worked out freely upon the beam, thus thoroughly cleansing the stock preparatory to tanning.

The best time for fine-hairing is after the drenching, as the grain of the skins is then cleaner, and the fine hairs more easily seen. This enables the workmen to get better results.

Pigeon manure is considered the best bate for calfkid and sides, and should not be used over 95 degrees in winter and 90 degrees F. in summer. The bran drench should not be above the temperature referred to, and is used in all kid-tannages except chrome.

The period which the hides or skins remain in the bating solution is dependent upon the temperature of the bate and the thickness of the material subjected to its action.

Borax and boracic acid make good bates when dissolved in water; they work out the lime, but do not eat away the hide substance.

Puring as conducted by manufacturers of light leathers, is done for the purpose of removing the lime from the skins and preparing them for tanning.

The method pursued is to ferment an emulsion of bran, middlings or flour, till it is quite acid, then putting the pelts or skins into this fermenting mixture. The acids formed by the fermentation make soluble salts of lime in the skins, and the bulk of water dissolves the salts of lime out of the skins by the subsequent washing. During this operation there is quite a quantity of carbonic acid gas generated which, collecting under the skins or pelts, causes them to rise. When the skins are first thrown into the drench they sink to the bottom, but as the fermentive action generates the carbonic acid gas, they come to the surface, and the liquid becomes covered with a white foam. This has no connection with the drenching proper, being only an effect of the fermenting action and the liberation of gas. The workmen can best judge when pelts are drenched by their appearance and feel. There are several objections to this fermentation of bran for drenching, it being a dirty, long and uncertain operation. The decomposing ferments that break up the starch in the bran into acids permeate the skins, and are carried over into the tanning liquids, causing an acid fermentation in them. There is also a risk of weeds, etc., which contain tannin, being in the bran or middlings, depositing a certain amount of tannin in the skins while in the drench bath, causing spotted and cloudy results in the tawed or tanned stock which afterwards produces uneven coloring. Drenching is an essential operation to the preparation of nice leather. To leave any lime in the stock makes hard, brittle and cracky leather.

In tanning with salts and alum it is absolute ruin, as the alum loses some of its sulphuric acid, making sulphate of lime (common gypsum), which makes the skins harsh and hard, it being almost impossible to soften them.

To leave lime in the skins to be tanned with tannin or other vegetable extracts means the production of brown spots, darker color and a brittle grain. Leaving lime in skins to be used in the chrome process means the production of sulphate of lime in them, due to the acid used in the first bath with bichromate of potash, also producing a brittle grain and hard leather.

The removal of lime is essential in making good leather, yet to remove it by means of the bran drench is dirty and troublesome.

Hides that are intended for sole leather are generally, after they are unhaired and fleshed, merely washed or rinsed, then immediately put into tan liquor, and handled until colored, then shifted on consecutively. Some tanners who have the facility, cleanse them more, and by this means get a better color, but still there is a large quantity of lime in the interior, which sours the liquors, and if they are not soon removed from it, the hide gets soft and flabby by the loss of gelatine which it causes. This would be prevented if the hides, after fleshing, were put into a bath that would extract the lime, and yet extend the fibrine, so that it grows continuously, and after well scudding it will be more developed, and better fitted to imbibe tannic acid.

Dressing leather is universally bated in the United States, and many other countries, but it is supposed no bates are used by the French, who excel all others for qualities of upper leather. It should be said they do not use excrement, which we say cannot be done without, yet we have seen upper leather manufactured in the United States without its use, far superior to any where it has been used. We know that where lime is used for depilating, it must be extracted before good upper leather can be made. This should be done by a non-impoverishing agent, so that the hide is not reduced, but is left with the whole body to be matured and utilized.

When the unhairing has been properly done, all hides and skins should be properly cleansed from the depilatory agent, whatever that agent may have been. Lime is not so deleterious to sole leather as to offal used in some countries for insoles, but still it defiles the liquors and does not improve the sole leather. All sole leather should be thoroughly cleansed from lime; however, we would not advise that sole leather be bated with the excrement of animal, which destroys a large percentage of the gelatine. A good bate for sole leather and one which is used in many of the large tanneries of this country,

although kept a secret, is that discovered by Trumbull in 1847, which consists of sugar, or molasses; the proportion used being about 6 pounds to 100 gallons of water. This solution forms a soluble saccharate of lime. We have seen some excellent sole leather produced by the use of this bate, a much greater additional weight being secured than could otherwise be obtained.

The object should be to cleanse the hide or skin from the deleterious materials used in the unhairing process. We prefer the term puring, *i. e.*, get the hide or skin pure from all alkaline matter without decomposing it. It will then be full, soft, and velvety, instead of an empty rag. We read sometimes that a calf-skin should be so reduced that you may pull it through a finger ring; but, to test this, let a calf-skin be tanned as it comes from the butcher. After cleansing well from the blood and dirt, can it then be pulled through a large ring, and will not the leather be firm, stout, and good?

The practice of reducing the hide or skin is so universal among tanners and so consolidated, that it requires electrical agency to dispel the illusion; even those who are the most desirous to get an improved mode of puring hides and skins from the depilitant, cannot believe it can be accomplished if the pelt is not reduced so as to leave it a mere rag, as is done by excrement bates, which consume the gelatine while combining with the lime.

It is useless for us to profess anxiety for improvements in our manufactures and expect to find our goods acted upon by improved methods to appear the same in every stage as they do by old methods, if the altered mode produces no different appearance. What different result can be expected at the finish, and as bating has much to do with weight and quality, how can weight and quality be improved, if the pelt is persistently reduced?

What are the impurities but lime, fat, and dirt, commonly called scud, and the fine undergrowth of hair? But even the undergrowth of hair should have been so loosened by the depilitant that no difficulty should arise in removing it in scud-

ding. The lime and fat should be assimilated by the pure, which with the dirt would form a kind of soap, and would yield to the scudding knife and leave the pelt intact without reducing it, as all usual bates do by attacking the fluid gelatine which it draws from the hide or skin. And from force of habit tanners say it is properly reduced or bated, and if this fluid gelatine is not extracted, they say it is not sufficiently reduced and will not make good leather for the purpose required.

The time is approaching when this axiom will be discarded. The necessity is even now apparent by the large imports of light leather taking the place of goods that we manufactured ourselves in olden times for our own consumption. Very light goods are required for some branches of the trade, and it is said this can only be got by reducing the skin in the bate; but if the proper skins were selected and manufactured with the whole constituents left in, superiority would be obtained, for the fluid gelatine is the lubricator of the fibrines in life, and is as important an agent in preserving fineness of texture and mellowness, flexibility and toughness of leather when finished.

While we practice bating for sheep, goat, calf, kip, and cow or yearling, for producing a soft pliable leather, we do not as a rule use bates for sole leathers, which are required to be firm and solid; these are generally only washed or rinsed from the lime and lightly scudded, then put into the handlers and moved till they are colored, souring the liquors and making them worse than useless. We would advise puring these from lime also, though in a different degree than for light dressing or dyeing goods, and the leather though not harsh would be firm, tough, and would not grind away like that in which a large quantity of lime remained; the weight also would be improved, for the antagonism between the alkali lime and the tannic acid when they first come in contact, results in the decomposition of gelatine, until the alkaline properties are overcome.

Not being able to get colors right in glove leathers is generally due to poor bating; lime is the great enemy. When skins are pickled a chemical change takes place, the lime put

in the skin being changed to sulphate of lime by the sulphuric acid, and this clogs the pores of the skin so that no tan liquor can get in, but the lime can work out and act upon the colors. Sulphate of lime is not soluble in water. It is soluble in lactic acid, and it is for this reason that tanners who use sour liquors have no trouble with lime, as the sour liquor contains lactic acid. Lime left in is sure to produce hard, brittle leather. On the other hand bating must be done with care.

Among the many ways of earning a livelihood is that of collector of dog-pure, an individual frequently to be met with in the tannery districts of Paris, where he goes to dispose of his ware.

In common with the excrements of other carnivorous animals, that of the dog contains an acid, which, it is claimed, has hitherto defied artificial production, and has the property of "cutting" the grease and fat adhering to fresh skins; it also softens and bleaches the skin, and first quality dog-pure is valued above all other dung for the reason that the acid it contains is just powerful enough to produce these results without injuring the delicate fibre of the skin. Dog-pure is used by manufacturers of fine sheep leathers, especially those making leathers for covering corset steels or for purse-linings, and many of these establishments are said to have their regular salaried collectors.

The pure is prepared for use by dissolving in water maintained at a temperature of 5 to 10° C. for several weeks. When "ripe," the "preserves," as the appetizing mixture is technically termed in France, is "skimmed," that is, the "cream" removed for use, the residue consisting of small bones and other detritus, which dogs have an unfortunate habit of swallowing, and which would be apt to injure the skins. The latter are then placed to soak in the decoction, where they acquire that velvety softness so much appreciated.

The theory of dung bating, while obscure, is that a chemical combination is formed with lime under the influence of the agents of which the droppings are composed, the ammoniacal

chloride parting with its chlorine to form the chloride of lime, which is readily dissolved in water.

Hydrochloric acid possesses the property of dissolving lime in the manner accomplished by the bate, as was shown by MacBride in 1774.

Carbonate of ammonia was employed by Warrington in 1841, for accomplishing the purposes of the bate.

In addition to the substances named, carbolic acid, sulphuric acid, dilute phosphoric acid, organic acids, muriate of ammonia, alum, etc., are employed.

Some of the objections to the present method of bating in addition to its expensiveness are:—

1. The disagreeable odor and uncleanliness attendant upon the use of the excrement of animals.

2. The difficulty in obtaining properly skilled labor to superintend the operation, which is necessary because of the tendency to decomposition produced by the use of animal excrements. This decomposition is designated by tanners generally as "running away," and means literally that the skins are frequently decomposed into a state of liquid putridity, and only skilled tanners by watching the vats can detect the approach of such a condition.

3. Then there is such great difference in the strength of the same kind of animal excrements, as that of dogs for instance (due to the different varieties of food upon which they have been fed, vegetables, bones, etc.), that practically no definite period can be positively set within which it is safe to let the excrement operate.

4. The influence which the electrical condition of the atmosphere has upon stock in the bate, which is frequently damaged or spoiled during thunder-storms.

The bating is usually accomplished by placing the hides or skins in a vat having a circular and tight bottom, over which vat is arranged a revolving paddle wheel marked 1 in Fig. 35, which dips into the solution contained in the vat, thereby agitating it and maintaining the sides or skins in constant motion,

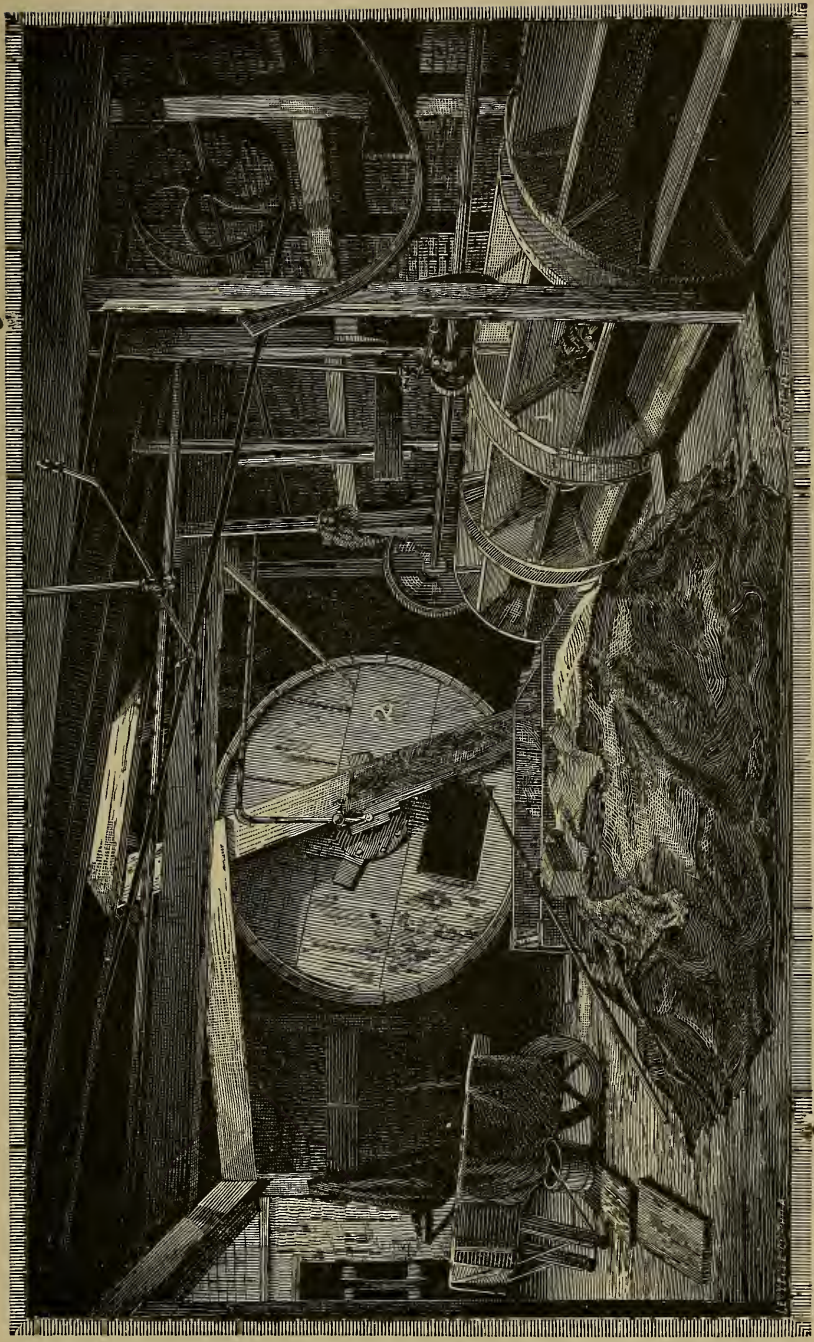


FIG. 35.

VATS AND WHEELS FOR BATING AND WASHING.

thus hastening the work of bating and greatly lessening the time and danger of spoiling the material in the bate.

After the sides or skins have been properly treated they are placed in the interior of the wheel or drum, marked 2 in Fig. 35, and washed with clear water for a few minutes.

The English wheels used for agitating the bate liquor, and the wheel used for washing the sides or skins, are shown in perspective view in Fig. 35.

When the sides show the right condition scouring is proceeded with, this operation being effected either by hand or by a hide-working machine, or the scouring may be performed by the Vaughn, Whitney or other macnines shown in Figs. 28 to 34, at the time of unhairing and fleshing, if the latter operations be performed by machinery.

The object of this scouring, which should not be confounded with the scouring which is to be hereafter described for removing the bloom from the hides after tanning, is to free the hides from lime and dirt and fit them for the reception of the tannin ooze to which they are first subjected in the handlers.

In the preparation of sole leather the hides are scraped on the grain side with a curved knife in order to cleanse them from lime remaining in the pores after the last soaking, and this operation is termed "graining."

FINAL SOAKING BEFORE PLACING THE HIDES IN THE OOZE.

After treating the hides and skins in the above manner, and being assured by the previously described tests that they have been sufficiently soaked, it is only necessary to replace them in water for 5 to 12 hours longer. The safest indication of the hides and skins being ready for the ooze is that, when passing the fingers over them, strokes remain as indentations.

CHAPTER X.

HANDLING AND PLUMPING.

HANDLING.

THE occasional removal of hides or sides from the vat, and then replacing them, also the agitation of the stock at stated times while remaining in the liquor in the vat, is termed "handling," the object of which is to equalize the action of the lime in the unhairing process, the bate in the bating process, and of the weak liquor or ooze in the first stage of tanning.

The old manner of handling hides, like most of the primitive methods of the tanner's art, was exceedingly slow as well as laborious; but of late years numerous appliances have been perfected for mechanically performing this work, by means of which the stock is handled with great facility and at the expenditure of but little labor. One old method was to haul up the sides by hand from the vat and pile them, and in this condition, allow them to press and drain, and then after a sufficient time throw them again into the vat.

Another and later method was to "shift" or change the sides from one vat over into another by means of hooks.

Handling and transferring the sides by the medium of a revolving device, such as the reel, is an old-fashioned method which has not yet become obsolete; but which continues to be employed in the majority of both small and large tanneries in this country; in large tanneries the reel being operated by power.

This manner of handling seems to be both convenient and economical, and as there are but few objections that can be urged against it, there are at present but slight chances of it being generally abandoned for later processes, of which we have a great variety.

There are two modes in vogue of connecting the sides, which are to be handled, with the reel. One is to tie them together with strings and the other is to connect them with a tie-loop; but the first method is most commonly employed, and is the least expensive.

The hand-reel is about three feet high, and is made as light as possible, consistent with requisite strength, in order that it may be readily moved by two men from one vat to another.

When in use the reel is placed on the alleys intermediately between the two vats in which the hides are to be handled, and the sides or hides are drawn over the drum by the workman who turns the crank attached to the shaft on which the drum is fastened. Two men are required to operate this reel, one to adjust the sides or hides in the head vat, and the other to work the crank.

Another form of handler in use is known as the rocker handler, and it consists of a frame constructed of wood, and hung by pivots in the centre of the top of the vat so as to give a dipping movement of 7 or 8 in. to each end of the frame, and the sides are hung over sticks placed across the frame from the two sides, motion being usually imparted to the handler from shafting placed overhead.

The apparatus shown in Figs. 36 and 37 was invented by L. C. England, in 1871, and consists in a good method of keeping the stock suspended in the liquor, so that all parts may be brought into constant contact with the ooze, and its employment in liming, bating and handling should produce a smooth grain and good quality of leather.

Fig. 36 is a perspective view of the apparatus, showing it removed from the vat. Fig. 37 is a vertical section of the same, showing it applied to a tan-vat.

The frame F is made to conform to the interior of the vat, and consists of the upper and lower rails, S, S^1, S^2, and S^3, and the cross rails E, E^1, E^2, and E^3, which are joined together by means of the uprights U, U^1, U^2, U^3, and U^4, and which uprights serve as guides to retain the frame in a horizontal position.

The frame *F* is also provided near the lower part with two diagonal braces, *B*, *B*[1], at the point of intersection of which is an upright shaft *R*, to which power is applied to operate the frame, the braces serving to agitate the liquors.

FIG. 36.

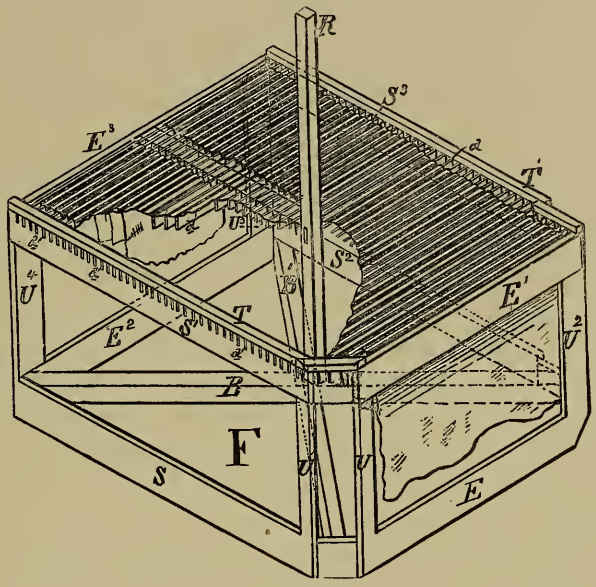
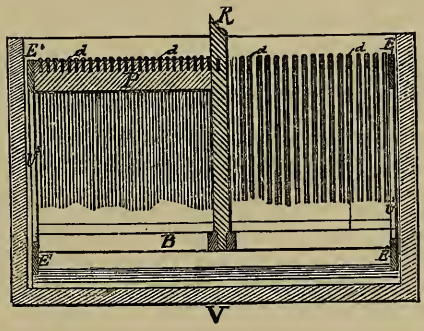


FIG. 37.



The series of bars *d d d*, are held by the binders *T*, *T*[1], which prevent them from shifting as the frame moves downward.

The stock is hung on the movable bars *d d d* with head and butt down, and the proper liquors supplied.

The frame is placed in the vat so that the top of the stock resting on the bars may be about eight or ten inches, more or less, below the surface of the liquors.

The whole frame is then caused to move upward in a vertical line of a few inches, four to six being sufficient, but should not be allowed to raise the stock above the surface of the liquor. The stock being loose on the bars will, when the frame moves downward, be left suspended in the liquor, entirely free from contact with the bars, thus allowing the liquor free access to the parts of the stock, which, when the frame is at rest, adheres to the bars on which it is placed. The upward and downward vertical motion given to the frame will keep the stock at nearly the highest point to which it is raised by the first stroke of the frame upward, the frame being moved faster than the stock would sink in the liquor if unobstructed. Every returning upward stroke of the frame will carry the stock back to the highest point again. The frame is caused to move only so fast as will have the desired effect, and at intervals, as occasions may suggest.

The specific gravity of the frame and stock being very small, the power required to give the necessary motion while they are submerged in the liquor is correspondingly small.

The paddle wheels for handling shown in Chapter IX., Fig. 35, which were also invented by L. C. England, in 1867, are largely employed in handling heavy, medium, and light leathers.

These wheels work within three-quarters of an inch of the sides and are usually five and a half feet in diameter, and have eleven paddles about seven-eighths of an inch thick, and spaced equidistant apart, which is about eighteen inches between centres at the outer edge.

The vats in which the wheels revolve have the bottom concave to conform to the convexity of the wheels which are placed over the centre of the vats, so that the wheels dip about eight

inches in the liquor, and thereby cause a gentle but thorough agitation of the ooze and stock, which moves in an opposite direction from that of the wheels.

The motion of the wheels causes the stock to move up in front, pass under the wheels, and down on the concave bottom to the back of the vat, and thus by means of the paddles, and the constant changing position of the stock, a thorough and gentle agitation is maintained. But if the bottom of the vat should be made square, the agitation would be too great to answer the purpose.

No fixed length of time can be set for running these wheels, as the period depends upon the stock being handled; light sides, as those used for upper leather, being handled for a shorter period and not so often as the heavy whole hides employed for making enameled and patent leathers.

The wheel, should for no class of leather be run at a greater speed than eighteen revolutions to the minute, and the motion should be steady and regular. Cog-gearing is best, and possesses a great advantage over belting, as the latter, from the slow motion required, often becomes troublesome.

Wheels of this kind are generally arranged in a line, as shown in Fig. 35, and sometimes so constructed that any one of them can be thrown out of gear, by means of a clutch connected with the loose pinion on the shaft.

It has at times been tried to apply these wheels to quicken the after-process of tanning; but while they answer for light leathers, it is the opinion of some who have experimented with them upon heavy leathers that they will not answer; but notwithstanding this opinion, we have seen them successfully employed at Newark, N. J., and other places, for tanning heavy whole hides to be used in the manufacture of enameled leather.

This wheel furnishes a most simple and effectual mode of moving the incipient leather in the liquor, and does away entirely with the necessity of handling by hand, facilitates the after-process of tanning, economizes in labor, forms a handsome grain, and in all respects improves the quality and texture of the leather.

Methods of handling, such as lacing it together and drawing the stock through rollers, or placing the hides, sides, or skins upon a web, unlaced and feeding the stock to the rollers, are not now employed in this country. However, they continue to be profitably used for some classes of leathers by a few European tanners, the theory being that by pressing the liquor out of the pores in handling upon re-immersion, the liquor into which the stock is placed acts more quickly and in the end produces a heavier weight than is ordinarily obtained.

In the manufacture of grain and split leathers the sides are tacked upon sticks and handled into stronger liquor about every three days, and it might here be stated that any method of handling which allows both the grain and flesh sides to be uniformly exposed to the action of the liquor will fill all the requirements, provided there is a gentle agitation of the fibre at occasional periods.

In some portions of the country the handling is performed by placing the stock in the interior of a large revolving drum about 10 feet in diameter, one-half of which turns in the liquor of the vat, the centre shaft upon which the drum is supported turning in bearings resting upon the top of the vat.

The interiors of these drums are best divided into three or four compartments, as it is easier upon the green stock than allowing it to be treated in an unpartitioned wheel, and besides the operation of the contrivance is facilitated by retaining a portion of the contents near the centre.

In Gorsline's apparatus for handling, the sides or skins are placed in the vat resting upon five straps, having cross slats attached to them, and one end of each of the straps is attached to the top of the vat, and when it is desired to raise the pack, the centre strap is wound around a drum which gradually raises it, and as it approaches the top, the operator standing upon the alley can easily seize the hides and throw them out.

The slats slide over the centre strap which winds upon the drum, thus preventing them from striking the frame and stopping the machine.

In raising the pack the inclined position it assumes has a tendency to wash off the sediment or bloom, presenting the same advantage in this respect as in handling by hook in the ordinary way.

This contrivance is better adapted for handling kips and skins than for heavy sides or hides.

PLUMPING.

The swelling or "plumping" follows the unhairing and fleshing, and after the bating of the hides, which has been described, and it consists of a more or less prolonged immersion in an acid liquor, which is gradually increased in strength. Its essential action consists in completing the swelling of the cells, distending the pores, and thus favoring the absorption of the tannin. A secondary action takes place; it is a commencement of tanning due to the presence of a certain quantity of tannin in the liquor; the swelling being due to the action of acetic acid, and of the lactic acid. Both acids are products of decomposition and oxidation of the non-tannins, such as sugars, gums, etc.

Some wood vinegar may be added to the sour tan liquor in order to accelerate the swelling. This process does not cause any damage to the quality of the leather; but some tanners replace the acetic acid by sulphuric acid, which, at an equal degree of acidity, costs considerably less. This practice is prejudicial to the quality of the leather. It is true that the swelling is satisfactorily produced, and the leather looks well, but, prepared in this manner, it retains traces of sulphuric acid which corrode it internally after a time, and make it very brittle and more subject to alteration by moisture, and there are other defects which will be mentioned shortly.

The "plumping" process is applied to the heavier classes of hides only, such as those employed for the manufacture of sole-leather, upper-leather, harness, belting, patent and enamel leathers, etc.

PLUMPING BY MEANS OF SOUR LIQUOR.

There are at present two methods in common use by which

this plumping is accomplished, as has been stated, In one of these the tanning-liquor which has been in use for some time, is made use of under the name of "tailings," or sour liquor, in which the hide having been properly prepared is first placed.

The fresh tan-liquors after a short time become changed in their character and nature, and the resultant is a liquid in which we find tannic, gallic, and acetic acids in varying proportions, combined with decaying vegetable and putrescent animal matter; but the presence of the latter substances seriously interferes with the exhibition of those active principles which the tanner seeks to utilize from his sour liquors, and it is the presence of this decomposed matter that forms the only objection to this method of plumping hides, and from which the principal danger arises, which, while not great, still requires watchfulness.

The second method of plumping, which will be enlarged upon in the next section of this chapter, is to steep the hides in a cold, dilute sulphuric-acid liquor.

But while the latter method expedites the work, it has the effect of rendering the leather harsh, liable to be brittle, and gives a dark grain to the same, it being conceded by all practical tanners that the process in which the plumping is wrought by the presence of the acetic acid in the tailings is far preferable, could the same be divested of the trouble arising from the decaying animal and vegetable substances present in all tanning-liquors which have been used for any length of time.

H. J. Botchford, of Leyden, N. Y., proposes to remedy this by subjecting the sour liquors to a distillation in a still suitably constructed, by which the acetic and other volatile acids are recovered in a pure form, freed from the other substances of the liquors. The distillate thus resulting is now taken, and, in a properly dilute form, is again used as a liquid in which the plumping of the hides may be very expeditiously and satisfactorily accomplished.

In the practical working of this process the distillation is best accomplished by the use of a still in which the liquors from which the acid products are to be recovered are heated

by means of a steam-worm coiled within the body of the retort containing the said liquors, the vapors of the acids thus liberated being conducted from the head of the retort through a tubular condenser, the temperature of which is maintained at a sufficiently low point for the proper condensation of the acid vapors by surrounding the same with water at a low degree of heat; but any apparatus ordinarily termed a "still" will answer, as long as its materials are arranged to be proof against the attack of the acids to be recovered, and the heat of which can be maintained equally.

PLUMPING BY MEANS OF SULPHURIC ACID.

In 1773, David MacBride, a physician of Dublin, introduced the employment of sulphuric acid for swelling or plumping hides, and though it may appear strange that such an improvement should have been made by a member of the medical profession, still this, like many other advances, was the result of accident, which arose from a series of experiments carried on for purely medical purposes, for confirming a theory that an infusion of malt would cure the sea-scurvy.

MacBride for four years kept the matter a partial secret, imparting the knowledge to only one firm of tanners in the city of Dublin; but on May 31, 1777, after being at liberty to disclose it, he did so in a communication to the Royal Society, and it is recorded among the Philosophical Transactions.

Sulphuric acid or vitriol, as it is also termed, is used for plumping both lime and sweat stock. The coloring and plumping of the latter are usually accomplished simultaneously in the handlers, the liquor being strengthened after the removal of each pack.

But while vitriol can be employed without danger on limed stock, it is desirable to observe caution in employing it upon sweat stock in order that it may not be too much swelled, as its action is more energetic upon hides which have been subjected to the sweating process.

Some tanners find that it is an improvement to treat sweated

hides to a weak lime bath, especially when they are to be plumped by sulphuric acid.

The acid is diluted with cold water, and sometimes more or less of the old sour tan liquors are employed in conjunction with the sulphuric acid, in order to hasten the process of preparing the hides for the tanning proper.

It is, of course, impossible to give the exact proportion of vitriol to be employed in every case; but the quantity now used is about the same as that prescribed by MacBride, more than a century ago, viz., to use his own language, "a wine pint of the strong spirit of vitriol is sufficient for fifty gallons of water to prepare the souring at first; therefore, all you have to do in raising sole leather, is only to prepare it beforehand in the usual way, and when it is fitted for the souring, mix up a quantity of vitriol and water, according to the number of hides that you require to have raised, still observing the proportion of a pint to fifty gallons, which will be enough if the vitriol be of the due degree of strength. The hides may lie in the souring till you find them sufficiently raised, for they will be in no danger of rotting, as they would be in the common sourings, which in time might turn putrid and rot the leather, whereas the vitriolic liquid keeps off putrefaction."

In the early use of sulphuric acid by our tanners, an almost general lack of knowledge of the nature and effect of sulphuric acid under certain conditions was largely prevalent, and much harm resulted from its injudicious employment in the handlers; but while practical experience has done much to aid the tanner in obviating disastrous results, there is still much desirable knowledge regarding its use in tanning that can result only from chemical experiments.

The most concentrated sulphuric acid is a definite combination of forty parts sulphuric oxide and nine parts of water, the formulas representing it being H_2O, SO_3, or H_2SO_4, and it is a colorless oily liquid having a specific gravity of about 1.85, of intensely acid taste and reaction.

Oil of vitriol has a most energetic attraction for water, it

withdraws aqueous vapor from the air, and when it is diluted with water great heat is evolved, so that the mixture requires to be made with caution.

The atmosphere is invariably charged with moisture, sometimes to the point of extreme dampness and complete saturation, while at other times it is considerably above the point of saturation. Any raw material, therefore, which is exposed to the atmosphere absorbs to a greater or less degree a certain quantity of water. Some chemicals absorb a large percentage and are on this account called hygroscopic.

For example, ordinary sulphuric acid or oil of vitriol has a great affinity for water, and a glass half full of acid, will, if exposed, gradually fill up and overflow with water, added by the mere attraction of moisture from the atmosphere. Sulphuric acid is an extremely hygroscopic substance, the moisture absorbed being considerably over 100 per cent.

The specific gravity of sulphuric acid being so much greater than tan-liquor, it has at all times a strong tendency to settle and mark with spots of different colors the grain of the pack, and is is only by strict watchfulness that this can be avoided, and when vitriol is added to the pack, it should be done before the sides are thrown in, and the plunging should be faithfully performed in order to prevent the discoloring of the grain by the settling of the acid. The swelling or "plumping" process is, for the reasons previously stated, accelerated, and the falling back of the hides into their previous state prevented by the use of hard water.

PLUMPING BY MEANS OF ACETIC ACID.

The most experienced tanners do not consider the use of acetic acid as advantageous for swelling sole leather. While it is admitted that the acid will make the cellular substance of the hide absorb water and thus swell, and will also prepare the gelatines of the hide for the further processes of tanning, but the acid will destroy the albumen and the albumen cells of the hide. For this reason, hides tanned in old acid liquors are

always weaker, soft and spongy. Mineral acids are still more destructive, as they coagulate the albumen of the hide and give it a brittleness, while they also attack other constituents of the hide and prevent the natural fermentation of the liquors. If sole leathers in the first liquors are swelled by the use of mineral acids, the albumens cannot come to the surface of the hide. The gelatines will be dissolved, but according to the strength of acid used will be more or less decomposed, and the result will be that the finished leather will look bad as to color, but will be hard and liable to crack. Fir tannins are supposed to contain more acid-swelling properties than either mineral or acetic acid, and German tanners add it to their liquors and allow it to ferment for this purpose. This is considered the only proper means of swelling hides without injury to the cellular tissues or the destruction or displacement of the albumen of the hide. Lactic acid is a good agent for plumping hides—the only objection to it being its present high cost.

CHAPTER XI.

LAYING-AWAY.

THE hides having been raised, the texture dilated, and therefore weakened, and being deprived of that natural gum which absorbs moisture, are in a condition to be tanned, that is to have their fibres strengthened and re-united.

Tannin is, therefore, an astringent and impregnating substance, by the ageney of which the fibres maintain their independence and the faculty, as it were, of sliding one upon another in their moist state, and by the means of which, also, the dried leather is rendered manageable and elastic.

Without tannin the skin becomes horny as it dries, and loses all elasticity and malleability, which is due to the fact that the bunches of interwoven and compact fibrous cellular tissue, of which it is composed, stick together, and constitute then a continuous, semi-transparent mass.

Leather is probably not, as has been heretofore considered, a chemical combination of the animal substance with the tanning substance; for the reason that the latter * is never absorbed in equal proportions, but in variable quantities, according to the concentration of the liquid and the nature of the dissolvent. "One may even obtain leather by the sole use of fatty substances, for which there can be no question of a chemical combination with the animal tissue. Mr. Knapp has even succeeded in tanning or making leather without tanning elements.

* Some chemists object to this paragraph, one writing as follows: "It cannot be said that for the reason the tanning substance is never absorbed, etc., because a piece of leather which is thoroughly tanned, when shredded and treated with petroleum naphtha to remove fat, oil and water, and to thoroughly remove all soluble matter, such as tannin and non-tannins, always contains about the same amount of hide substance and tanning substance after deducting the mineral matter or ash."

Starting from this principle that the filaments adhere or stick together only when they are swollen by water, he has put the hide in contact with such a liquid as alcohol or ether, which, expelling the water by endosmosis, deprives the fibres of their faculty of sticking. He has obtained in this way a tawed skin, of a nice white color, and having all the physical qualities of tawed hides. The same result is obtained by suspending a cleansed skin in anhydrous ether placed above a layer of chloride of calcium. The water with which it is impregnated diffuses itself in the ether and is gradually absorbed by the chloride of calcium. Any leather thus prepared—the only difference in which from the moist hide, dried and horny, consists in the physical state of the fibres, which have kept their independence—becomes an ordinary skin, with all its qualities, as soon as it is moistened.

"It results from these interesting experiments that tanning is based rather on a physical action than on a chemical reaction. The tanning substances, penetrating the hide by endosmosis, envelop the fibres, adhere on their surface through an attraction similar to that which causes the precipitation of coloring matters on the surface of textile fibres. The fibres thus surrounded by a layer of foreign matter do not adhere any more in drying.

"The faculty which the tanning substances possess besides, of rendering the leather imputrescible, is independent of their physical action. It may disclose itself more or less energetically, according to the more or less antiseptic nature of the compound used.

"A very interesting experiment of Knapp shows besides that one may compare the leathers, as regards the solidity of the tanning with dyed tissues, some of which are of good tint and others of false tint.

"Thus the hides tanned with tan-bark resist the action of water, while those prepared with the tannin of the gall-nut come back to the state of untanned hide, after a prolonged wash with carbonate of soda, which proves that the active

substance of tan is not entirely identical with gallotannic acid." *

Following this theoretic discussion we shall now proceed with the final step in the process of tanning heavy hides and skins, such as are employed for sole and upper leathers, etc., which is the laying away of the stock. The usual size of the lay-away vats for sole leather hides is nine feet long, seven feet wide and eight feet deep, and in these the stock is usually placed with the grain side up in order to avoid "hook marks" in removing them.

The stock is laid away by being spread out smoothly and upon the bottom of the tanvat, and between each layer there is sprinkled a slight thickness of ground bark until the vat is filled by the stock and bark thus laid in *stratum super stratum*.

Tan-liquor is then run into the vat, and when the interstices are filled the whole is crowned with a layer of bark which tanners call a "heading."

Formerly the inter-laying layers of bark were depended upon to do the tanning; but at the present time in this country the bark-liquor is relied upon and not the inter-laying bark.

The bark ought not to be shaved too fine for the lay-aways. This is important where whole hides are tanned. It is not so important where sides are tanned. If the bark is too fine, it excludes the liquor from circulation between the hides, and they do not come out of the lay-aways fully tanned.

In the early stages the green stock requires more attention than when it is nearly tanned, as at first it absorbs the tannin very rapidly and then gradually its capacity for absorption grows less until at the finish it refuses further to imbibe the tannic acid. The skins do not absorb an unlimited quantity of tannin, and are probably not improved by remaining a long time in the vat.

The number of layers and the period of each differ for the various leathers, and depend upon the substance and weight of

* Wurtz. Dictionnaire de Chimie, Pure et Appliquée, iii., 193 *et seq.*

the stock, the strength of the liquors to which it is subjected, the season of the year and various other appendant matters; but it is not uncommon in this country to tan the heaviest sole-leather in four layers of the following periods, the liquors at the end of each stage being of the indicated degrees of strength, which gradually increase from say 6° at the start, to about 30° at the finish:

1st layer,	12 days	. . . . .	15°
2d "	18 "	. . . . .	20°
3d "	24 "	. . . . .	25°
4th "	36 "	. . . . .	30°

Making the whole period ninety days, and in some cases it has been accomplished in much less time. See Chapter XXIV.

In order to obtain full weight and brighter color the time of the final layer is prolonged, for when insufficient time is allowed to this layer there will be lack of solidity and the grains will be inferior.

In the manufacture of finer grades, such as oak-tanned sole-leather of the kind which is used for the soles of ladies' and children's shoes, the packs are generally laid away five times. New liquors, or mixtures of new and old, are preferable for dry hides, old liquors for slaughtered. When laid-away in bark the packs are changed, as has been stated, until tanned. Much care and judgment are necessary in proportioning the continually increasing strength of the liquors to the requirements of the leather in the different stages of the process. The liquors should also be kept as cool as possible, within certain limits, and ought never to exceed a temperature of 80° F. Too high a heat, with a liquor strongly charged with the tanning principle, is injurious to the life and color of the leather, and the use of a too weak one must also be avoided. Hides treated with liquors below the proper strength become relaxed in their texture and lose a portion of their gelatine. The leather loses in weight, and is much more porous. The greatest strength of

liquor used for handling should not exceed 16° by the barkometer: and that employed in laying-away should mark at its greatest strength from 30 to 35°.

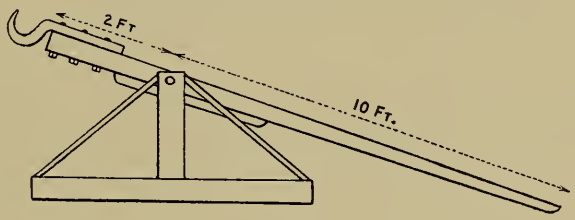
It is the custom, when the liquors in the lay-away vats are gradually increased in strength, to remove the packs after the stock has laid-away long enough, and run the ooze through wooden pipes into a receiver, and from thence to pump the liquor back to the leaches, where it passes through the bark and is restrengthened, and then run as new liquor into the vats.

Another method is to allow the fresh and strongest liquor direct from the leaches to pass first upon the head packs of the last layer, and from thence to the next, and so on through all the layers, and of course decreasing in strength and becoming more acid until it finally passes upon the first lay-aways, or into the handlers, where it is exhausted.

When this method is employed the liquors when they come from the leaches should be at least 30° and ought not to exceed 35° in strength; but the liquor should never in the end be allowed to remain upon the stock after the strength is spent.

When heat is used on the head leaches the liquor sometimes enters the lay-away yard in a hot condition, and the intent is of course to turn it into the head lay-away; but sometimes the attendant by mistake allows it to run on the green stock, thereby causing damage to the leather, as the "black rot" will be certain to set in to greater or less extent, especially in the heated season of the year.

FIG. 38.



The jack shown in Fig. 38 is used for raising whole hides up in the lay-away vats so that the men can take hold of them.

When the whole hides are laid away, they are placed upon a float made by floating two sticks about two inches square lengthwise of the vat on top of the liquor, and then lowering a piece of timber 4x6 inches so that it will be in the centre of the vat at right angles to the length. This timber has a hole through each end, through which passes a rope which is long enough to extend about two feet above the top of the vat. Two short sticks are then laid across the two long sticks near the ends, and the hides are then laid away in the usual manner.

As laying away continues, the float sinks. When the time comes to raise the hides, a jack is placed alongside the vat and the end of the rope wrapped around the hook on the end of the jack, and the hides are gradually lifted to the full extent of the jack, and the rope is wrapped around a movable peg, which is placed in a hole 1½ inches from the edge of the vat in the alley or partition which separates the vats. Then the jack is carried to the opposite side of the vat, where the operation is repeated.

In tanning heavy upper leather the practice among some of our best tanners is to first handle the sides on sticks for ten or twelve days, and then lay them away twice in bark, both lay-aways generally extending over a period of about sixty days, the first lay-away being for about twelve days and the second for about forty-eight days. After this the sides are split and then, after being leveled off, the sides, twenty-five at one time, are placed in a large revolving wheel and worked for about ten minutes with moderately strong gambier liquor. From thence the sides go again into the handlers, but this time without sticks, and are drawn each day for about fifteen days. This completes the tanning of the upper leather, and it is then ready for the scouring and finishing.

Light upper leather, such as grain and splits, is not laid away.

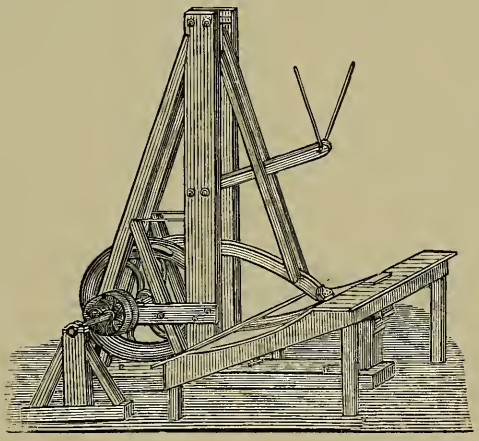
CHAPTER XII.

STONING.

PREVIOUS to splitting, leather is usually "stoned out" to remove the wrinkles in the sides. This is best done with a stoning jack.

Fig. 39 shows the stoning jack made by J. T. Freeman & Co., Woburn, Mass., and it is one of the best machines made for the purpose.

FIG. 39.



STONING JACK.

This is a very strong jack, and is especially constructed for stoning out rough leather preparatory to splitting. It will stand a very heavy pressure and is just the machine to take out the wrinkle in rough harness or belt leather, etc.

The Vaughn machine shown in Chapter XVI is also invaluable for stoning out previous to splitting.

CHAPTER XIII.

SPLITTING LEATHER.

AFTER the sides have been removed from the handler vats they are—in the manufacture of upper leather and some other varieties of leather—hung on poles in the yard of the tannery to harden, or pressed in a power press sufficiently dry for the splitting machine, and then carried to the cellar preparatory to being split. For other and more minute details in relation to splitting leather the reader is referred to the chapters treating of the manufacture of grain and split leathers.

Fig. 40 shows an interior perspective view of the cellar of an upper-leather tannery. Piles of sides that have been dampened, and in condition to be split are shown at 1 and 4. The three splitting machines in a line, marked 2, are known as the Union Splitting Machines; the one in the background marked 3, is the Belt-Knife Machine. The manner in which power is supplied to the machines by means of a line-shaft is shown, the line-shaft being marked 5.

For those who are building or equipping tanneries, views of this kind contain many valuable suggestions, as those in this work were taken under the author's personal supervision from some of the most modern and concededly the best arranged tanneries in the United States.

SPLITTING MACHINES.

Early in 1831 Alpha Richardson, of Boston, Mass., patented his first splitting machine for leather.

Seth Boyden, of Newark, N. J., had nearly a quarter of a century previous to this invented a machine for this purpose; but while a large number of machines of this character had

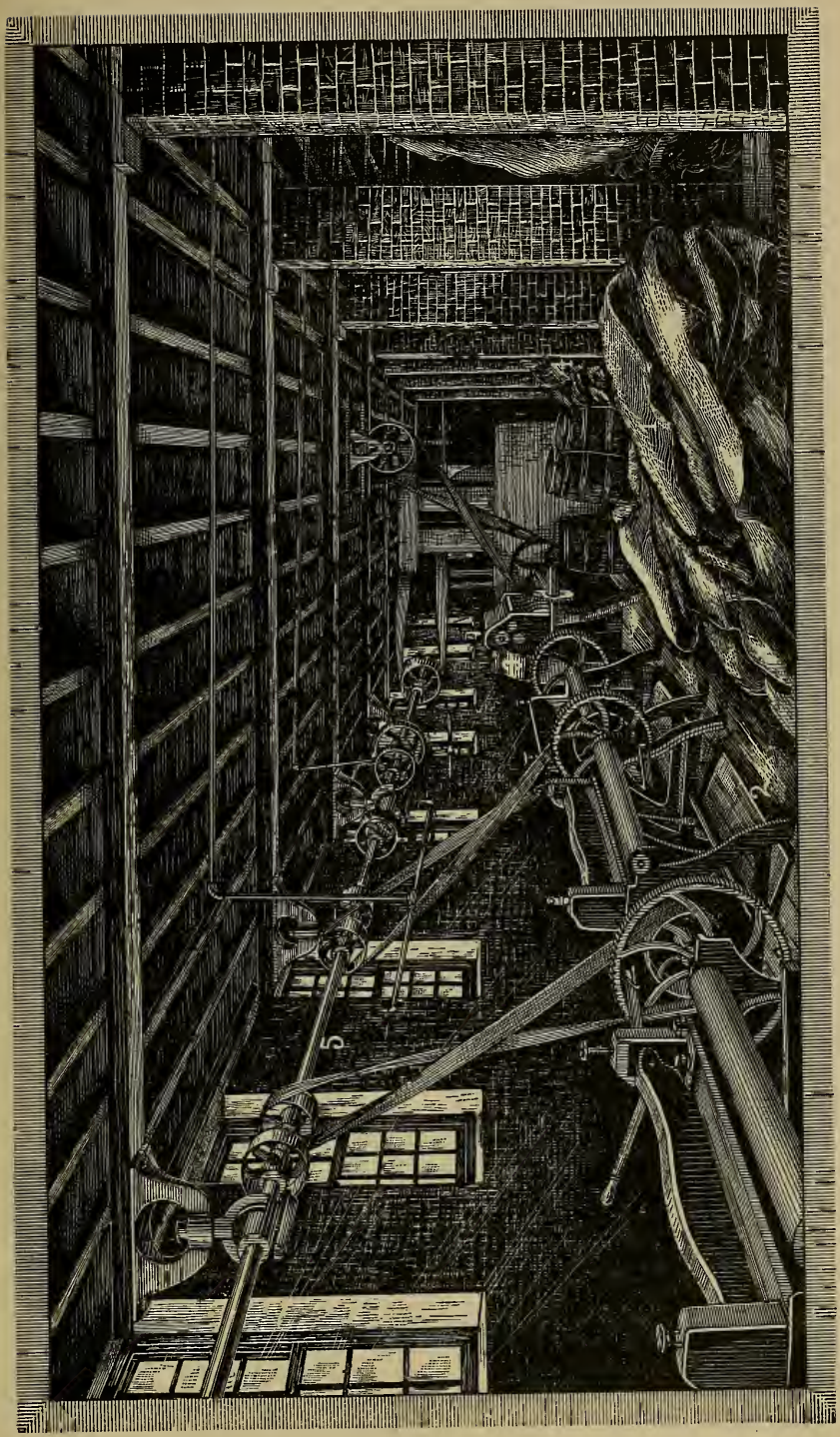


FIG. 40.

THE CELLAR OF AN UPPER-LEATHER TANNERY.

come into use, there were numerous objections to them which it remained for Richardson to overcome.

He gave great attention to the perfection of his contrivance, and continued to improve it until 1856, when he combined all his patents in the "Union Splitting Machine."

Since the successful introduction of splitting machines hides have been split to meet all required conditions, and they may be split either in a green or tanned state.

In the manufacture of heavy upper leather the sides are split after being only partially tanned.

When it is desired to split whole hides, as in the manufacture of enameled leather for carriage tops, etc., a machine constructed on a different principle is employed. The one in most common use for this purpose is known as the "Belt-Knife Splitting Machine," which was invented in 1854 by Joseph F. Flanders and Jere A. Marden of Newburyport, Mass., and which machine is now manufactured by The American Tool and Machine Co., Boston, Mass. The Belt-knife Machine has almost driven the Union Splitting Machine out of the eastern currying shops, but the latter machine is still employed in the western states.

The facilities afforded by machines of the character that have been mentioned, allow good "grain splits" to be obtained, which are used very largely for shoes, and also for harness, trunks, etc., and the large production of buffed and grain leathers, which are now so much used in this country, and form an important item in our export list, has been greatly aided by them.

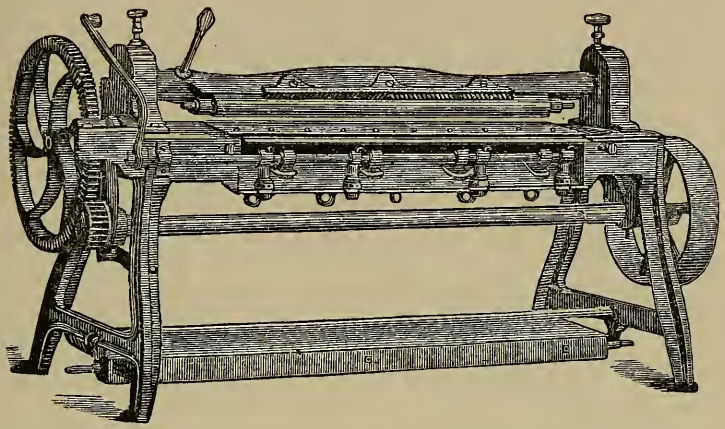
Fig. 41 shows a perspective view of the Union Splitting Machine, geared so as to be run by steam power.

Fig. 42 shows a perspective view of an attachment patented in 1883 by John A. Enos, to prevent injury to the arms of those who operate the ordinary splitting machines of the character which have been described above.

As generally practiced in the factories where leather-splitting is carried on largely, the leather is held pressed against and

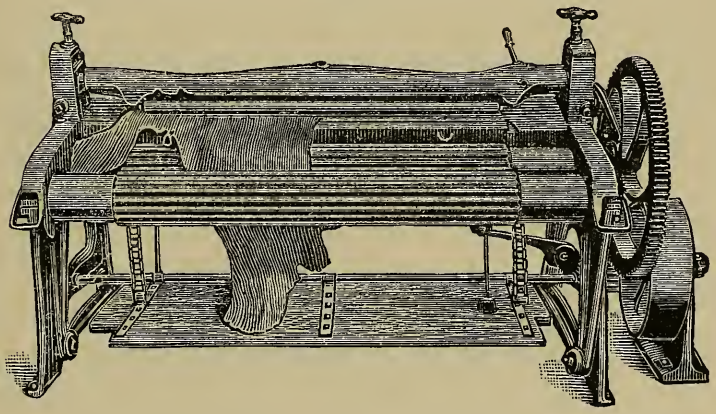
wrapped around the drawing-roller by the hands of the operator, who is in great danger of being caught and having his arms broken, such accidents being of very frequent occurrence.

FIG. 41.



Machines have also been made in which the leather has been drawn or fed against the edge of the knife or cutter by a pair

FIG. 42.



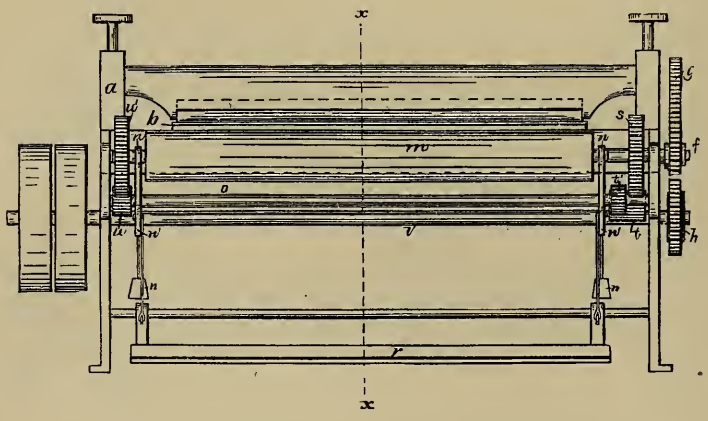
of cylindrical rolls which act upon the opposite surfaces of the leather, pinching it between them; but when a stationary knife

or cutter is employed, it is claimed that it has been found impracticable to use such a pair of feeding-rollers, as their holding power is not sufficient to draw the leather uniformly against the edge of the cutter. Enos discovered that by fluting or corrugating the surfaces of the drawing or feeding rollers, and preferably also gearing them together, so that the projections or convex portions of one roller will fall within the recesses or concave portions of the other roller, it is possible to obtain sufficient holding power upon the leather to draw it properly against the edge of the knife and split the leather.

Enos's invention is shown in detail in Figs. 43 to 45, and consists, essentially, in the combination, with the usual splitting knife and parts co-operating therewith, to present the leather properly to its edge, of a fluted or corrugated drawing roller and a corrugated or fluted auxiliary or gripping roller, and mechanism by which the operator can force the rollers against the leather between them.

In the present embodiment of this invention the gripping roller is mounted in bearings upon pivoted arms, which are acted upon by an actuating-treadle to draw the gripping roller

FIG. 43.



toward the drawing-roller, and the gripping-roller is drawn back or retracted by its own weight or other suitable retractor,

so that the operator by merely raising his foot can at once relieve the pressure on the leather, which will then cease to be drawn.

Fig. 43 is a front elevation of a leather-splitting machine embodying Enos's invention; Fig. 44 an end elevation thereof; and Fig. 45 a vertical section on line *x x*, Fig. 43.

The framework *a*, knife *b*, and mechanism for presenting the leather to be split to the knife-edge, may all be of any usual

FIG. 44.

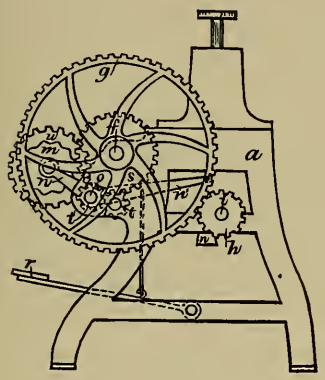
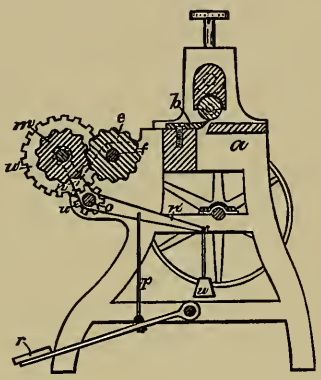


FIG. 45.



construction, these parts not constituting the present invention. The leather presented to the knife at a short distance from the end of the piece or side has its end carried over the corrugated or fluted drawing-roller *e*, mounted on a shaft *f*, shown as actuated by a gear, *g*, meshing with a pinion, *h*, on a shaft, *i*, having the usual fast and loose pulleys for the driving-belt. Thus by wrapping the leather around the roller *e*, or pressing it against the surface thereof, the leather will be drawn against the edge of the knife and split by the power by which the roller is rotated, although it is necessary, in addition to the power, to provide means for holding the leather upon the surface of the drawing-roller. This is accomplished in accordance with the present invention by the auxiliary or gripping roller *m*, having its bearings in carrying-arms *n*, pivoted on the

shaft *o*, so that the roller can be swung or oscillated upon the arms toward and from the roller *e*. The arms *n* have extensions *n'*, forming therewith a bent actuating-lever for moving the roller *m* toward the roller *e*, the extensions or arms *n'* being provided with counter-balance weights, *w*, for partly balancing the weight of the roller *m*. The arms *n'* are connected by links or rods *p* with the actuating-treadle *r*, so that the operator, by depressing the treadle, forces the roller *m* toward the roller *e* to grip the leather between them. The roller *m* is corrugated or fluted to correspond with the roller *e*, as shown in Fig. 45, and the roller *e* is provided at one end with a gear, *s*, meshing with an intermediate *t*, that meshes with a pinion, *t'*, fixed upon the shaft *o*, which has at its other end a pinion, *u*, meshing with a gear *u'*, connected with the roller *m*. The gears *s* and *u'* are of the same size, and the pinion *t t'' u* are of uniform size, so that the rollers *m* and *e* rotate in unison in opposite directions and the projections of the one roller fall into the recesses of the other. The two rollers thus co-operate to grip and draw the leather, which passes down between the rollers instead of being wrapped around one roller, as in the machines heretofore employed. By the employment, in connection with a fluted drawing-roller actuated by power in the usual manner, of a corresponding fluted auxiliary roller—or, in other words, a co-operating pair of fluting, gripping, and drawing rollers—the danger to the operator, it is claimed, is removed, and the operation and capacity of the machine for splitting the leather are improved and increased.

In the old machines employing but a single roller, the leather, when wrapped around it, frequently forms bunches, causing inequality in the tension of the leather, and consequent inequality in the thickness of the split material.

Frequently difficulty in splitting is traced to simple causes, which are easily remedied. Sometimes the hides are not properly soaked, and at others the machine is not correctly adjusted. The leather should be soaked just enough to allow the water to penetrate the hide, and no more. After that it

should be allowed to mellow, which should be from twelve to twenty-four hours. Care should be taken to cover the edges with wet cloths or splits, and to put them in a clean place where they will not get grit. In most cases it will be found advantageous to soak them in warm water.

With the Union Splitting Machine the following hints may prove valuable: Before putting in the leather to split, turn the beam roller over on to the knife, and see if the center of the roller sits exactly over the edge of the spring plate, and, if it does not, adjust it by moving the two screws, one on each side in front of the gauge box; next see that the edge of the knife is slightly below the spring plate, and about the distance of a cent piece away; see that the spring plate is gauged exactly true along the edge. To prove this, place the coin on the face of the knife, and close up to the spring plate; run the coin across from one side to the other, and, if the plate is not perfectly even and square with the edge of the coin all across, regulate the same with the long spanner by moving the screws underneath; if the spring plate is not set perfectly true, unevenness of substance will be the result. In gauging, first try the machine on a split, so that little damage will be done if the exact distance is not obtained the first try, also see that the spring plate sits evenly on the screws all along; otherwise, regulate with the eye bolts that are underneath. To ascertain if the plate sits on the screws, strike the plate lightly with a hammer over the screws, and it will be noticed if the plate springs or not; allow the plates to be sprung slightly hollow from back to front. An important point to be observed is the proper sharpening of the knife. It is almost an impossibility to keep a knife true and the edges in good condition by hand sharpening. Care should be taken to clear the edges, and for this purpose Scotch or Tam O'Shanter stones are considered the best. After properly fixing the knife, place the leather across with the belly part towards the outside, and bring down the roller, taking care that the same is properly pressed home with the lever before starting the machine. When splitting whole sides, assist the belly part through as

much as possible by pulling at the edge; otherwise, the belly being longer than the straight edge, the surplus will be worked back and puckered up, cutting it in holes. If the sides are inclined to be baggy or pouchy, take the wood from the lip roller and place one hand opposite the bag or pouch, and work the machine until the pucker is drawn out; then again place the wood in lip roller and finish the side. When placing the hands on the roller to draw out a pouch, particular care must be taken not to allow the hands to get too far underneath round the roller, as the fingers are apt to be trapped with the leather, and the arm broken or pulled out, which has happened on several occasions.

THE BELT KNIFE LEATHER SPLITTING MACHINE.

The American Tool and Machine Co., of Boston, are the original manufacturers of the belt knife Splitting Machine shown in Fig. 46, having been manufacturing them for the last thirty years.

The original machine was developed after the expenditure of large sums of money and valuable time, and has been steadily improved during the past twenty years, particular attention having been paid to alterations and changes in the machine during the last three years. Their most recent machine is shown in the illustration.

In view of the fact that the first machines were built to run at a speed of about 150 revolutions per minute, its speed has gradually increased until now some of the machines are run at as high a rate of speed as 425 revolutions. This high speed is admissible on some kinds of leather, but for the general splitting work the builders recommend a speed of from 300 to 350 per minute.

The necessity and anxiety to do work and do it quickly, in order to reduce the cost of production, were not provided for in all cases, and the machines were not strengthened and remodeled to meet the high speeds and the most severe work demanded by the leather manufacturers until within the last

three years. Since then the builders have been making constant improvements and the machine has been practically remodeled, having been made much heavier in all parts that past experience had proven required strengthening, and the quality of the material of which the machine is made received special consideration, so that to-day they are turning out a machine that is made of the materials best suited to withstand the severe duties demanded.

This point was one that required long and careful experimenting to determine which material was best suited for the service. In many cases seemingly unimportant parts of the machine required the most care and experiment before the most satisfactory material to use could be determined on.

The high speeds of the present day require a massive construction and strength to reduce the vibration and strains, and it was found that the ordinary materials that could be purchased from stock were unsuited, and the American Tool and Machine Co. were therefore obliged to have special steel manufactured to suit the purpose.

The latest machines that have been put into the manufacturers' hands, and run by experienced men who have used these machines for the past fifteen or twenty years, have been pronounced much better, and the fact that the amount of repair work has been reduced nearly 75 per cent., indicates that the builders have a machine that is economical and exceedingly durable.

We would mention among other things that the builders have increased the weight of the machine very materially, thus making it stiffer and stronger. They have put on gears that are machine cut; the rolls and shafts are carefully turned; the screws are lathe made and are closely fitted.

These are small points, but the fact that the machine, in order to do good work, must be taken down and cared for and replaced, necessitates that all the screws and parts should be made of material that will stand the handling and the reassembling without getting out of true, without the threads stretching or the holes wearing unduly.

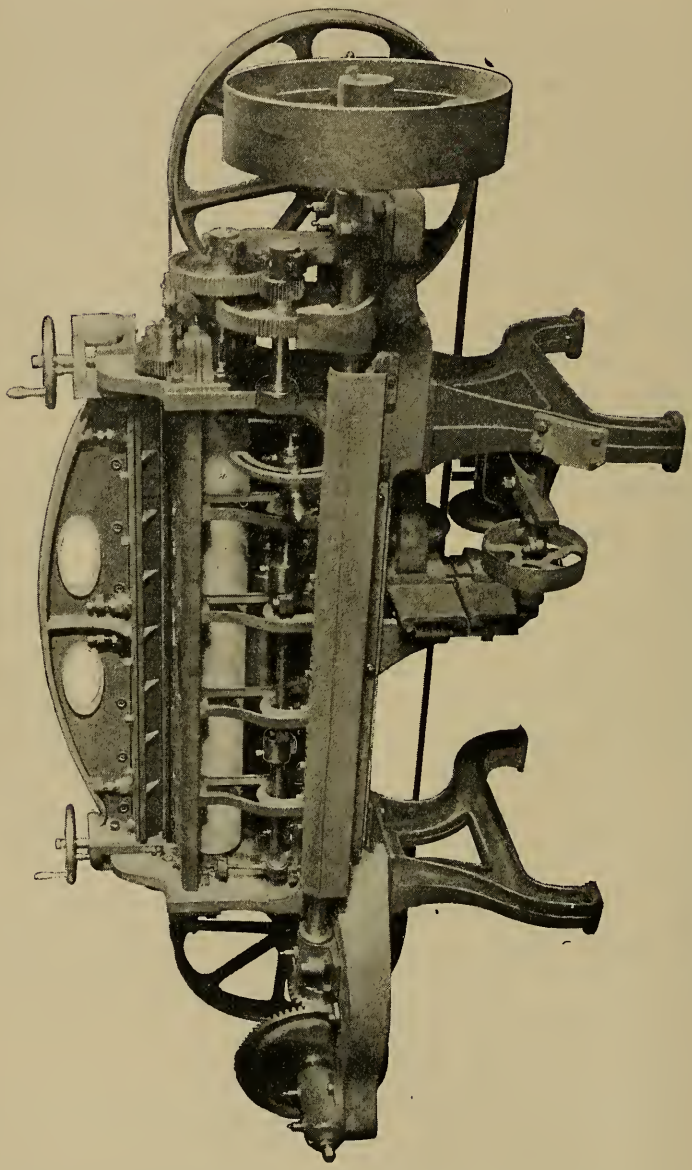


FIG. 46.

THE AMERICAN TOOL AND MACHINE COMPANY'S BELT KNIFE LEATHER SPLITTING MACHINE.

When the machine and parts are worn it is difficult to do close and good work and keep the knife properly adjusted.

The position of the knife and the beam and its parts is very important to do good work continually, and it is necessary that they maintain their adjustment after they are set, as the splitter must use up much valuable time and delay on the work by continually stopping to adjust his machine.

The machine is not automatic, and to insure the best work, it does not seem practical at this time to manufacture a machine that will automatically split leather; therefore to obtain the highest standard of work, it is necessary that a man should have experience in handling a machine and must understand something about leather in order to make a successful splitter. In setting up the machine and adjusting it, and getting out work properly, there are many things that will bother a man who is not thoroughly familiar with the machine, and it is only by careful study and the closest observation that the expert splitters are able and have been able to attain the position they hold. It has been very truthfully said by several of the most expert, that they have made the machine a careful study, and have really made it a life work.

These men can split anything in the shape of leather or material that can be cut with a knife that is required to be evened or divided into different thicknesses. There is no class of leather that is too difficult to split on the machine under the careful handling of the expert man; leather in all stages of manufacture from the raw state to the finished product.

As will be inferred from the above, it is practically impossible for a man to learn the art of splitting leather from any written description or written instruction that can be given.

We might mention that the belt-knife splitting machine is in successful operation for splitting pan-cake and counter stock, splitting shoe linings, splitting calf, goat and sheep skins, splitting and skiving grain leather, splitting book-binding and bag-stock, skiving harness leather and belt butts, splitting felt for hats, splitting and buffing leather for carriage tops and enamel leather, splitting green hides with hair on for robes and coats, splitting hides or skins from the lime; also celluloid in sheets and cow horns for combs.

Referring to the matter of grinders, we would say that the builders have been experimenting for some time on a new form of conveying the power to the grinder shafts, and that they will soon have a very simple, inexpensive arrangement, which we trust will be appreciated by all who use it.

It is always necessary on high speed machinery to provide a device for stopping and starting the machinery readily, as when a machine is running at high speed it is highly important that it should be stopped in case anything should become out of order, before any damage could be done to it; for this reason, the American Tool and Machine Co. have gotten out a new and improved patent friction pulley for the machine, by means of which it can be started with less power than the ordinary shifting belt requires; that is, the clutch that is provided with this pulley, is so constructed that the machine can be gradually started and instantly stopped.

IN REGARD TO SPLITTING LEATHER

a few instructions may not be amiss.

Everything being ready, place the leather in two piles behind the machine. Place it so the backs, as you pick it up, will come against the head blocks, the flanks at the middle; put the heaviest at the bottom, the lightest at the top, for as your knife wears away you are feeding larger leather which requires more room, you thus avoid resetting the knife so often. Take a side of leather, grain up, the hind shank first, the neck hanging down and the back hanging straight, lay it upon the ring plate, spread it as flat as possible, with one hand push or feed in the projecting part of the skin, with the other hand grasp the rib on the guard over the main shaft, holding thus the leather from feeding too fast. As soon as it begins to feed take the loose end and with the hand on the ring plate spread or straighten the side out so as to be sure not to let the leather catch at the two sides before the middle does, as otherwise the leather will not spread evenly, but bunch up in the middle. When that occurs you must stop the machine and raise the beam and draw it

back as far as it is bunched up, and turn down the beam and start again. Do not pull all the leather out or you may have trouble in starting in true again. When you have the leather well fed in, the width of the side, let it go, for the less hindrance you put upon the feeding the better the results will be. After you have split some twenty-five or thirty sides examine the knife, as the wheels are constantly grinding it away. You must keep resetting it; experience alone can tell you how much to keep the knife up to or away from the notch, but until you have had experience adopt one-eighth of an inch as a safe distance; or rather the nearer you can come and have a scrap of leather feed straight through when the machine is set, the better it will be. If the knife is too close the leather will not feed through, but will be carried by the knife along the jaw to the end. If you should, as is done in this country, skive the leather, the operation is the same, except you feed with the flesh side up to the gauge roll.

Of the various troubles which may happen, or the failures to do good work, we can say but little. The same thing seldom happens twice, and there may be more than one cure for any trouble, but as a rule, if the machine is properly set, the rubber roll straight, the rings all the same size and properly adjusted, the gauge roll and friction rolls true and straight and the jaw in condition to hold the knife, you must split well. Of course, the knife is to be kept well ground; you cannot split with a dull knife, and better wear out a knife a few days sooner than spoil your work. Be careful not to get oil upon the rubber roll, it will soften it and in a short time destroy it. When the roll gets out of true or very rough, you must get it ground down; be sure and keep it straight and smooth. The gauge roll will require turning off once in a while; it gets small in the middle. The bearings get worn down small and require turning up; when this is done, bore out the brass boxes and bush them with brass. After this is once done you have only to put in new bushing for a new roll, or for any subsequent turning of the old one. Once in a while take the brass rings

off the rod and put the end ones in the middle, the middle ones on the end. When you do this be sure every ring is separate and free to move and at the same time comes up so close to the next one that you can just see through them. By thus changing them you avoid turning them down so often; by keeping them close together you do not let them tip on the rod and make ring-marks upon the split. Use nothing but the best oil to oil up the machine, and see that every part is kept clean.

Too much care cannot be taken to prepare the leather before splitting. The best way is to wet it thoroughly and pack it down until it is entirely moistened through; it should retain water enough so that when you double the leather together and squeeze hard you extract a little water. If too dry there will be spots in it dryer than others, and such places always split differently from the rest. If you cannot wait for it to season, the next best plan is to mill the leather in a hide mill; in fact it would be a good plan to do this anyway. The plan of taking dry leather, wetting it in a tub and splitting at once is bad, and you cannot get good work in this way. If you skive the leather it should be jacked or stoned down to take the wrinkles out of the neck. Do this upon a stoning jack or stoning machine, such as have already been described in Chapter XII; you will find that you cannot spend too much time in preparing the leather to split, the result being amply better to pay for the time.

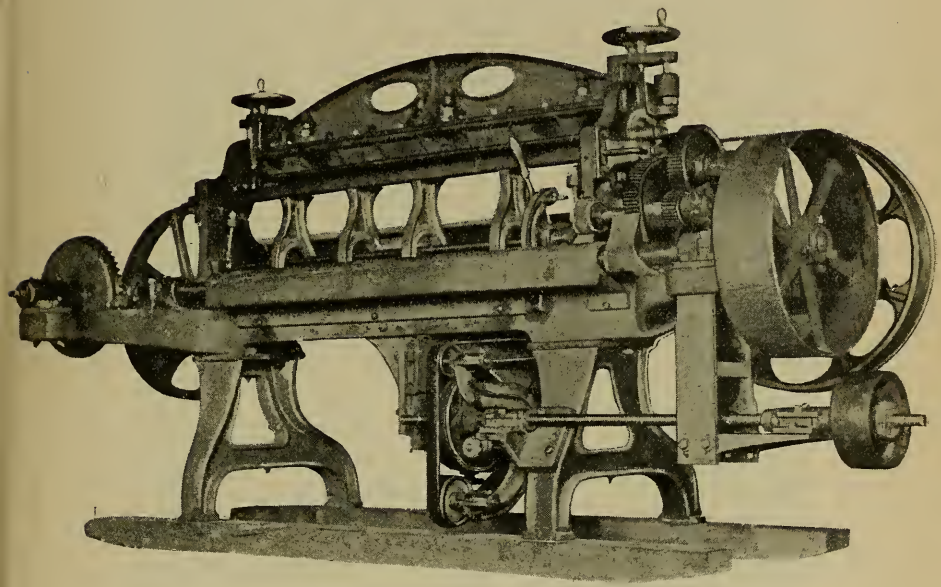
As to the amount of work, you must begin slowly and examine the work as you go along, but after a time you will find you can make about seventy to eighty cuts an hour, or even more; run the machine as fast as it can be fed well. A great deal depends upon the feeder; no machine will split well if the feeder is not able to do the work without continual stopping to pull back or straighten the leather.

The machines are made in four sizes, viz., fifty-seven inches (57″), seventy-two inches (72″), eighty-four inches (84″), and one hundred and six inches (106″). And can be used to advantage on both wet and dry stock.

The American Tool and Machine Company manufacture belt knives of the finest quality for their machines.

The Vaughn Machine Co., Peabody, Mass., are constantly adding new features to their business. Recently they have fitted out a shop adjoining their factory for the production of belt knives. They have machinery for grinding, polishing and straightening, and a special milling machine for cutting the

FIG. 47.



BASSETT'S BELT KNIFE SPLITTING MACHINE.

ends before brazing. All these machines are of their own invention and in use nowhere but in their shop. They claim they are making the best belt knives in the country, and the appearance of their knives surely assists to sustain this claim.

The Vaughn Machine Company have also become the selling agents of the belt knife splitting machine, made by the American Tool and Machine Company, Boston, Mass.

Fig. 47 shows a recent improvement on grinder rigging for belt knife splitting machines. The grinder is so arranged as to

save all floor space, and can be used alike on machines made by the American Tool Company, and those made by F. S. Bassett & Co., Woburn, Mass., which latter firm make and sell

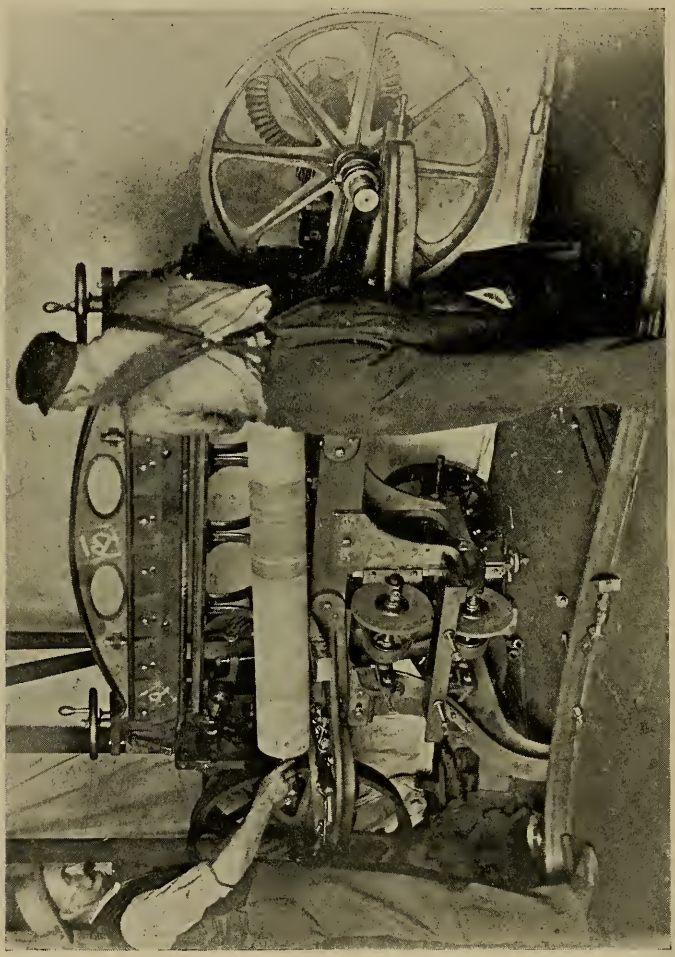


FIG. 48.

REMOVING THE RUBBER ROLL FROM THE BASSETT BELT KNIFE SPLITTING MACHINE.

the grinder rigging; the price is $50. F. S. Bassett & Co. also manufacture belt knife splitting machines, of which they have sold a large number to tanners and curriers not only in

the United States, but in France, Germany and England, and which are all giving complete satisfaction.

Bassett & Co. claim that their belt knife splitting machine is the most convenient to operate of any on the market, and that it will leave the leather in condition as good as or better than that of any other for the following reasons:

1. The machine is strengthened in places which have been considered weak in machines built heretofore, thereby making it less liable to vibration.

2. The improvement in regard to the removal of the rubber roll shown in Fig. 48 is a great convenience to the operator, as in all other machines the work requires about five hours. In this machine the roll can be removed in twenty minutes, thereby saving half a day's labor, which is quite essential when a machine is required to run ten hours per day to keep up with the work.

3. The bevel gears running the machine are absolutely noiseless and run perfectly smooth, which is a great improvement, as the gears used on all other machines not only make a great deal of noise, which is very annoying to every person in the room, but also tends to corduroy the leather. The hammering of the cogs when worn a little seems to rattle the knife so that in grinding the same it is more apt to leave an uneven surface, which tends to corduroy.

Every machine is guaranteed, and competent men are sent with each if required.

Aside from the above advantages, the Bassett machine has all of the modern improvements used on other makes.

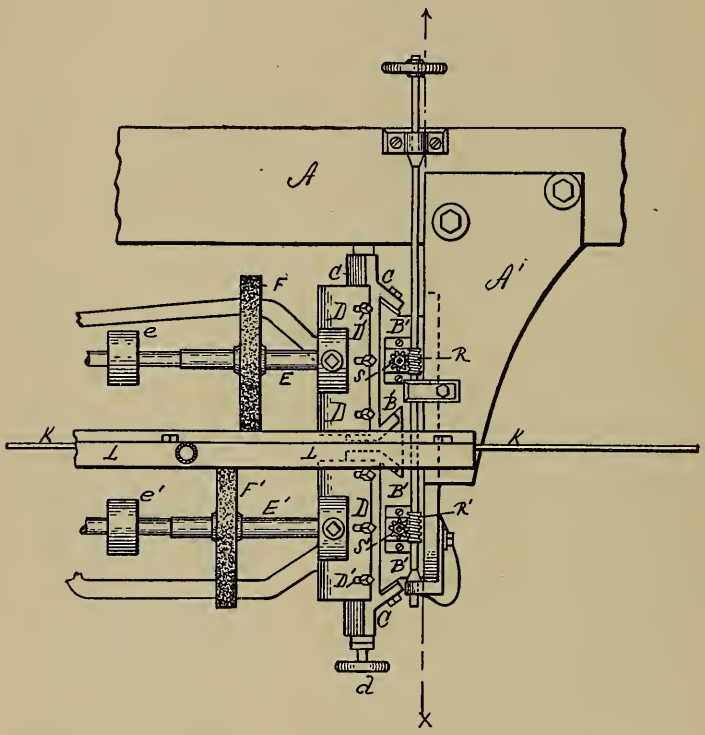
Bassett & Co. also keep on hand emery wheels and all duplicate parts of the belt knife splitting machine.

ROBERTSON'S GRINDING ADJUSTMENT FOR BELT KNIFE SPLITTING MACHINES.

The invention shown in Figs. 49–52 is that of James Robertson, of Woburn, Mass., the most expert splitter on the belt-knife splitting machine in the United States. It is in use by a large number of the leading tanners in this country and it is a valuable addition to the belt-knife splitting machine.

This is an improved movement or adjustment of the belt-knife of a leather-splitting machine, whereby opening of doors or kneeling by the operator is rendered unnecessary, uniformity produced in the bevels on the opposite sides of the knife, and economy attained in the wear thereof, all with the effect of im-

FIG. 49.



proving the quality of work produced by the splitting-knife. The invention consists in the novel construction and arrangement of parts hereinafter described, and illustrated in the accompanying drawings, in which—

Fig. 49 is a front elevation of a portion of a belt-knife leather-splitting machine with Robertson's improved grinding adjustment applied thereto. Fig. 50 is a vertical section taken

on line x, Fig. 49, looking towards the grinders. Fig. 51 is a horizontal section taken on line y, Fig. 50. Fig. 52 is a detail

FIG. 50.

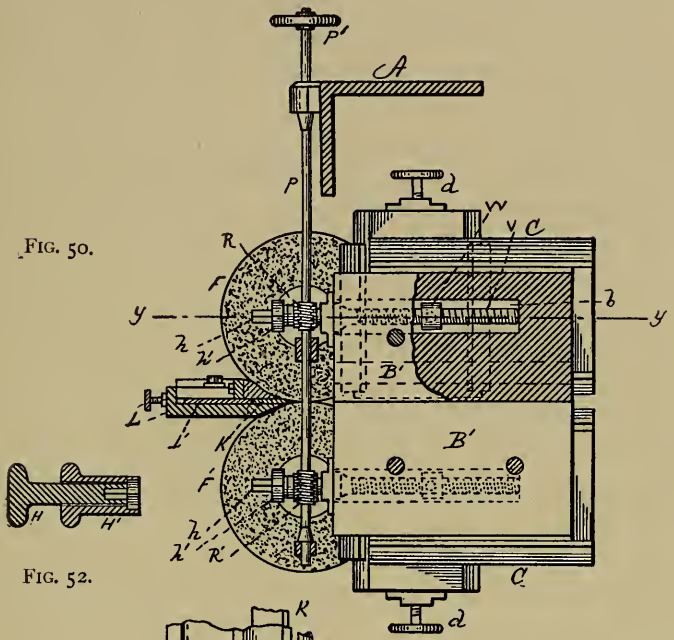
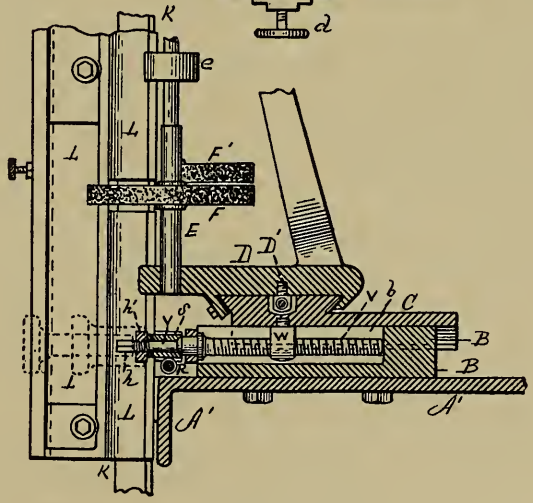


FIG. 52.

FIG 51.



in section of a wrench whereby separate hand adjustment of one of the grinders may be had.

A represents a portion of the frame of an ordinary belt-knife leather-splitting machine, and *A'* a bracket attached thereto. Secured to the bracket *A'* is a vertical piece *B* from which extend portions *B'* which constitute ways for the horizontal movement of the slides *C*, set one above the other, as shown in Figs. 49 and 50.

D D are carriages adjustably secured to slides at *D'*, Fig. 51, and having an independent movement (not new in this invention) whereby they may be moved up and down and out of the way, if desired, by the hand-wheels *d*.

E E' are shafts each having one bearing in a carriage *D*, (the other bearing being as usual, and not new). The shafts are driven by the pulleys *e e'*, and have rigidly secured to them the grinding-wheels *F F'*. The grinders *F F'* are set on opposite sides of the cutting-edge of the endless belt-knife *K*, which is driven in the usual manner, and is guided and supported by the grinder-jaw *L*, which contains a back-plate *L'* for the purpose of moving the knife forward as it wears.

P is a vertical shaft having its bearings in the frame of the machine and extending up to a point convenient to the operator, so that he can rotate it by means of the hand-wheel *P'* without stooping. On this shaft *P* are fixed two worms *R R'* which engage, respectively, two gears *S S'* which are fast to screws *V* extending into the recesses *b* in the ways *B'*. These screws engage nuts *W* which are secured to the slides *C*, Figs. 50 and 51. By rotating the shaft *P*, therefore, the screws *V* are rotated, thus moving forward simultaneously the slides *C*, and hence the carriages *D*, which move the grinding-wheels *F F'* simultaneously forward against the opposite sides of the edge of the belt-knife *K*, sharpening and beveling both sides thereof at once with absolute accuracy, and of course sharpening both sides absolutely alike.

Should it be desired to move forward one carriage and its grinding wheel independently of the other, an adjusting wrench *H*, Fig. 52, may be applied to either of the heads *h* of the screws or bolts *B*, the portion *H'* of said wrench being used to actuate the nut *h'* on said heads.

James Robertson, who is a practical currier of Woburn, Mass., also manufactures an appliance for regulating the distance of the knife from the centre line of the belt-knife splitting machine. This he sells for $3. He also makes another appliance for regulating the weight of leather to be cut on the belt-knife splitting machines, which he also sells at $3. These appliances do away with guess-work in operating the belt-knife machine and make the work exact.

He also manufactures a Leather Gauge which will tell instantly the weight of leather per square foot.

CHAPTER XIV.

SCOURING.

AFTER the leather has been split it is commonly handled in liquor for about two weeks, which completes the tanning process, and the next operations to which it is to be subjected are the drying and finishing for market.

Of course different varieties of leather pass through different modes of treatment, and while there is but little to be done in the finishing of sole leather, except the drying and rolling, there is much to be done in finishing upper leathers, Morocco leathers, etc.

We shall therefore devote one chapter to each of the subjects of scouring, stuffing, blackening and polishing leather, and then for other details of special branches of manufacture and for coloring and dyeing leather, refer the reader to the various chapters treating of those subjects.

The tools used in the hand method of scouring leather are the brush, stone and slicker; the brush is shown in Fig. 53,

FIG. 53.

and the perspective view, Fig. 54, shows the form of tables and other mechanical details connected with the hand method of scouring leather.

This manner is laborious and expensive, which has caused it to be superseded almost entirely by machinery.

The Vaughn Machine Co., Peabody, Mass., make brushes

suitable for scouring by hand. These brushes are of excellent quality, made from selected bristle.

MONK'S SCOURING MACHINE.

The Monk scouring machine, shown in Figs. 55 and 56, is built by the American Oak Leather Company, Cincinnati, O., and it is the simplest, most durable, and cheapest scouring

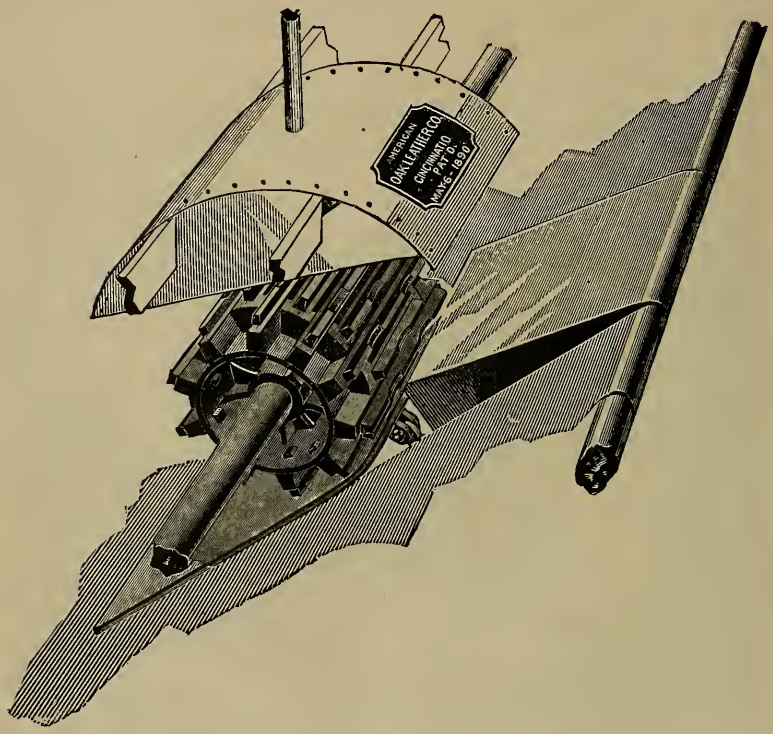
FIG. 54.

machine on the market, and will do more work per hour with less power than any other scouring machine which we have ever seen. It should be run at a speed of five hundred to six hundred revolutions per minute.

It can be used on the following leathers: sole, harness and upper, and it is especially adapted for scouring shoe leather splits, as it prepares the face of the split leather better and the

split will finish up finer than if scoured on any other machine. It is also especially adapted for scouring belt leather, as it scours the leather more thoroughly and it will do more work than any other machine of its class used in the trade.

FIG. 55.



VIEW OF CYLINDER SHOWING STONES IN MONK'S SCOURING MACHINE.

It has been found by experience that the fine North River blue stone in the cylinders does better work than if the cylinders were filled with stones and brushes. But this is a matter for the purchaser of the machine to decide, who can have the cylinders filled with stones or brushes as he may desire.

The leather adjusts itself to the stones during the scouring. The stones are not made the full length of the cylinder. Short

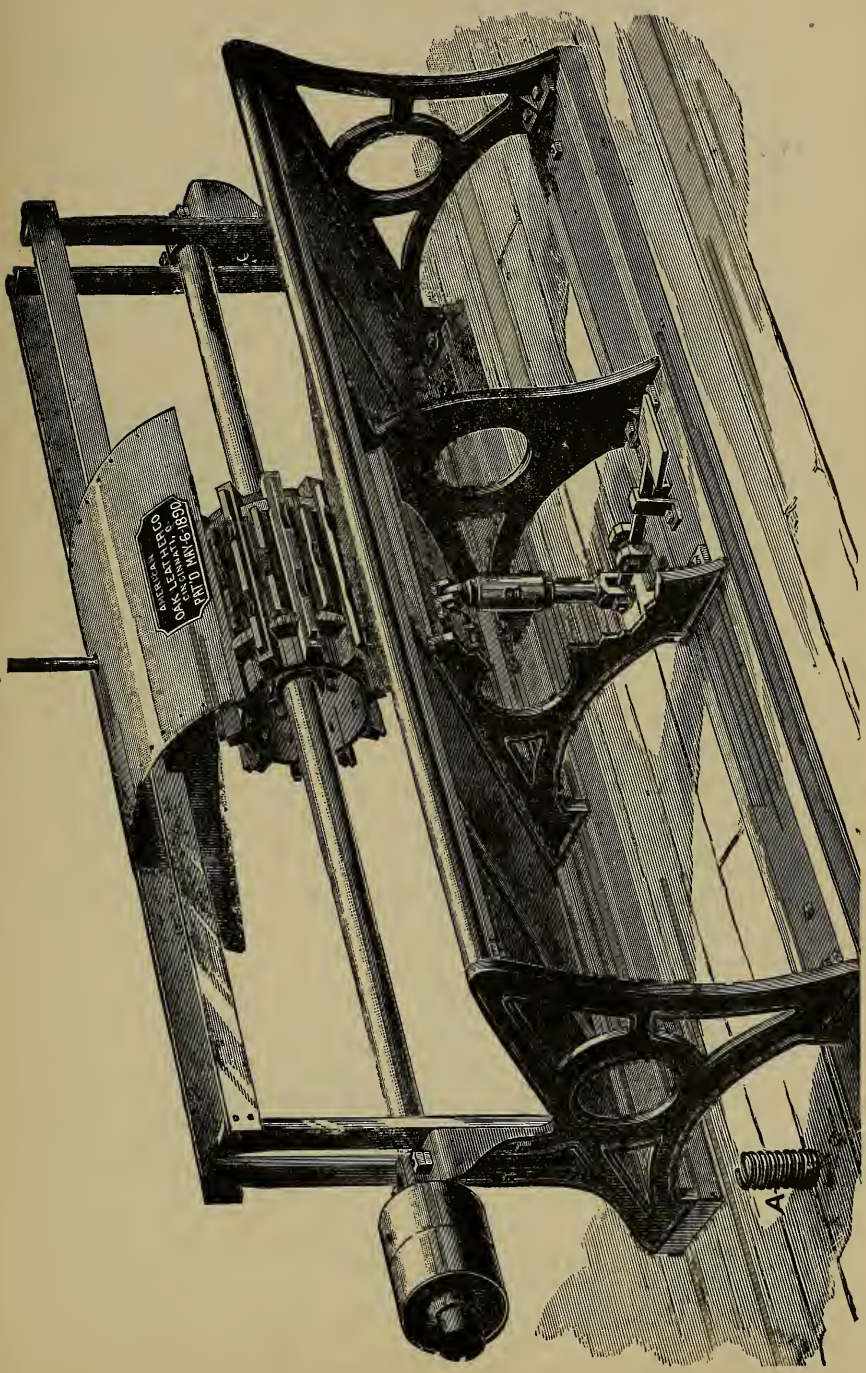


FIG. 56.

MONK'S SCOURING MACHINE.

stones cover the openings or gaps left by the preceding stones, as is shown in the illustration.

The same machine can be used as a brushing machine for all kinds of leather which may require brushing, by simply filling the cylinder with brushes instead of stones.

Fig. 57 shows the new vertical or upright constructed scouring and setting-out machine, built by the Vaughn Machine Company, Peabody, Mass. The builders claim for this machine a great gain in both quantity and quality of work over anything before known in the currying shop.

It will scour or set out, in the most superior manner, large quantities of upper leather, in grains, buff, glove, bag leather, fancy colors, wax, kips, splits or calf skins, and belting leather, either in the whole butts or in strips.

Its construction will at once recommend it for these purposes, as being simple, effective, and of the proper principle for doing the work, as the side, hide or skin, is placed lengthways on the vertical table, one-half on each side of the same, and is carried up between the two cylinders, which are revolving toward each other, and covered with blades arranged so as to thoroughly work and stretch the leather both in width and length at one and the same time, as will be seen by the cut of the machine. As much or as little pressure of the cylinders is applied to the leather as is wanted by the operator, with the foot lever. In this way the leather is much more thoroughly stretched, worked fine, and made firmer than it is possible to do by hand or any other machine.

In scouring, as will readily be seen from the cut and this description, nothing could possibly equal its principle, as the revolving cylinders thoroughly work out all the dirt, put the leather into perfect shape, and leave it fine, dry, even and smooth; a great point being that all the dirt, water, tan liquors, etc., expressed from the leather by the cylinders during this operation, fall to the floor, away from the table, and therefore cannot be absorbed by the leather again, as is the case in hand work or flat table machines.

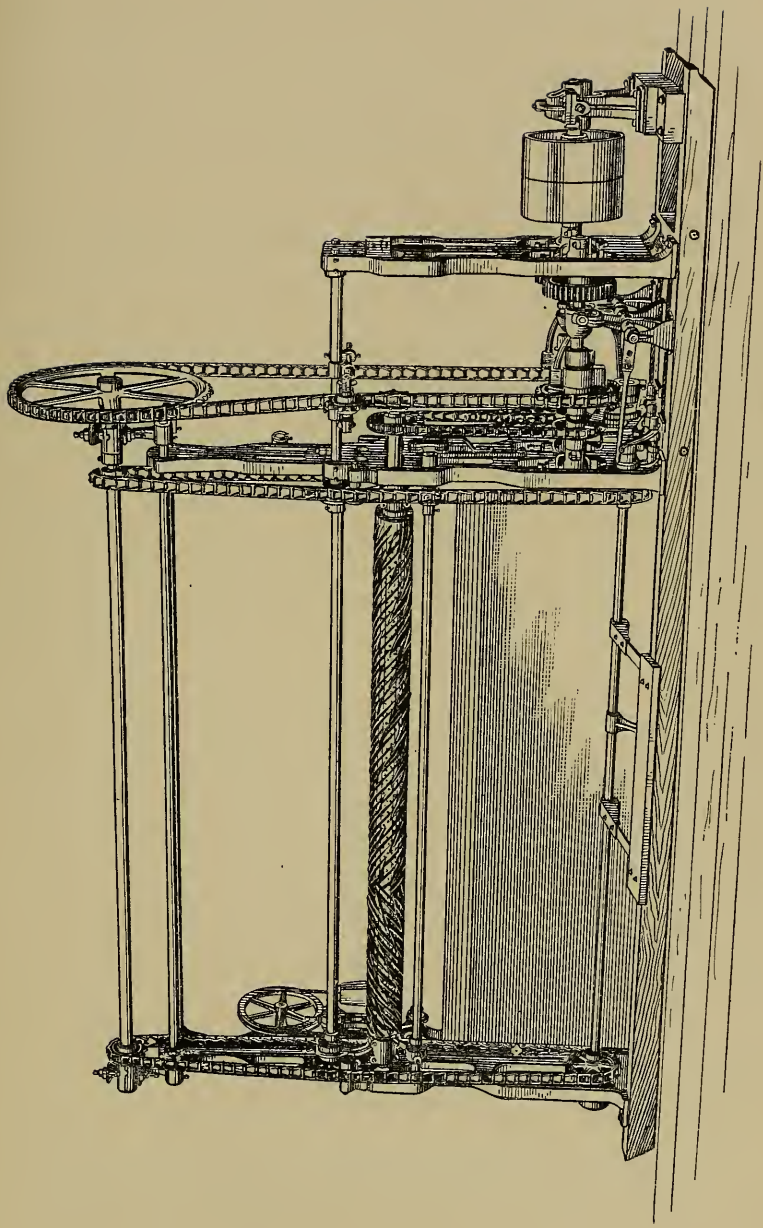


FIG. 57.

VERTICAL CONSTRUCTION SCOURING AND SETTING-OUT MACHINE.

For setting out fancy colored leathers the above points make it particularly valuable, and for setting out stuffed leather of all kinds, a great point is that it can be worked in a much colder and harder state than is possible to do by hand, thereby leaving the grease and weight in the leather, and having all the stretch that is set out, stay out.

The builders guarantee, therefore, that by the use of this machine the currier gets finer leather, and at the same time more measurement and weight, besides the saving in labor.

Made in all sizes from a 5 ft. to a 12 ft. in length of the cylinders.

But little power and small space required to operate it.

It is simple, strong and durable.

CHAPTER XV.

STUFFING LEATHER; OILS AND FATS; TESTING OILS; WATER-PROOF STUFFING; WATER-PROOFING LEATHER.

HAND STUFFING.

In the manufacture of upper leather, after the sides have been scoured as described in the preceding chapter, they are exposed to the air to harden and are next carried to the cellar of the shop to be dampened and tempered, so as to facilitate the absorption of the grease; the tempering process generally extending through two days.

The period of tempering depends upon whether the leather is to be stuffed by hand or machinery. When stuffed by hand the leather requires to be damper than when stuffed by means of the wheel.

Ordinarily the hand process of stuffing leather is accomplished after rolling the sides into bundles with the grain side in and softening them by treating or beating, and then applying to the flesh side by means of a brush, a mixture of oil and tallow in a heated state. In addition to the trouble and expense of the hand method of stuffing, another objection arises from the fact that the leather has to be dampened to such an extent that it necessitates a long period for drying, and then again, after the partial absorption of the oleaginous and fatty materials, the surface of the leather has to be separately cleaned of the unabsorbed matter.

Another great objection to the hand method of stuffing leather is that the stuffing materials, unless great care be observed, penetrate only slightly beyond the surface, thereby leaving the leather, as regards the main body, dry and unchanged, and consequently hard. But when the modern stuff-

ing drum is used for this purpose the leather is usually thoroughly permeated and thereby rendered soft and pliable.

The old method of hand stuffing is now passing away and in modern currying shops it is only used for certain classes of leathers.

DRUM STUFFING.

Drum stuffing is the most profitable, and turns out a more salable article. In these days of close competition, 1 pound in weight in a dozen kip butts, or a pair of harness backs or strap butts, is a very important item, especially if the same can be obtained leaving the goods a better color and a more salable appearance than if done by hand. It must always be remembered that stale goods will not carry the stuff as well as fresh ones, and goods that have had a good sumaching will, as a rule, carry the stuff more freely. In preparing the goods they should be dried out and then dampened on the flesh and grain sides and allowed to lie in a pile for a time covered with damp cloths, so that the moisture permeates freely through the leather, but not sufficiently so that the water can be squeezed out.

The next point is—what is the best material to use in stuffing? This depends on the quality of the goods; if they are of the best quality, we recommend the best grade of tallow and cod oil, no matter whether harness, strap or shoe work; but if they are of second or inferior quality, and especially if the goods are being dressed for the market, we would say that there is nothing to beat stearine, mixed with degras and neat's-foot oil.

It is not possible to lay down any fixed rule for stuffings, as all depends upon the quality of the tannage, and the grade of leather which it is desired to produce. The temperature of the drum and the temperature of the stuffing are also points which must be influenced by the same considerations.

In heating the drum close the door and turn on the steam for 20 minutes, the drum remaining stationary, then turn off the

steam and disconnect the pipe. It is very important that the steam pipe should be disconnected each time, because after a little wear there is sure to be an escape of steam, more or less, and consequently the scalding of goods, which is a very serious matter. After disconnecting the pipe, take off the door and allow the drum to run for five minutes, so that the steam may evaporate, then put in the goods as quickly as possible, and put on the skeleton door, and let them run for a few minutes before putting in the stuff; by so doing the goods will become broken up and more regulated; then stop the drum, put in the stuff, and put on the close door and run the goods for forty minutes. The stuff must be put in warm, of course, but not hot enough to scald the goods. After running for forty minutes, take off the close door and again put on the open door, and run the goods for another five minutes; that will allow the goods to cool down and become more even. The putting on of the open door is simply to prevent the goods from falling out as the drum is revolving.

The goods may now be taken out and opened out smoothly in a pile, and if they are not wanted for setting immediately they should be covered and kept as warm as possible, until such time as they are wanted for setting. What is best after taking from the drum is to place the goods in an air-tight box, until such time as they are needed. By keeping the goods moist and keeping them warm much labor will be saved in setting, and they will look much better for it. It is best to set the goods as early as possible after removal from the drum, for if they are allowed to become cool, it is almost impossible to get out the stretch. When the goods are unavoidably allowed to lie and get cold, it is well to have a tub of water by the side of the stuffing table, and dip in each side to soften it before proceeding to set the same. In setting, we recommend the use of marble or plate-glass tables, as they do not leave any impression on the flesh side after stoning, but give a smooth and close appearance to the flesh side, thereby saving both leather and labor in whitening. The goods should be stoned on the grain

with fine stone, until all old or growth grain is removed, then hung up nearly dry; then again take down and glass on the grain, removing all stone marks, and giving pattern to the leather; then again hung up until dry.

REED AND WINCHESTER'S STUFFING DRUM.

The stuffing drum shown in Figs. 58 and 59 is the invention of Reed and Winchester.

This invention in stuffing leather has for its object a method whereby the grease may be put into the leather more regularly than heretofore. The leather must be warm, and be kept warm uniformly during the time the grease is being applied to it.

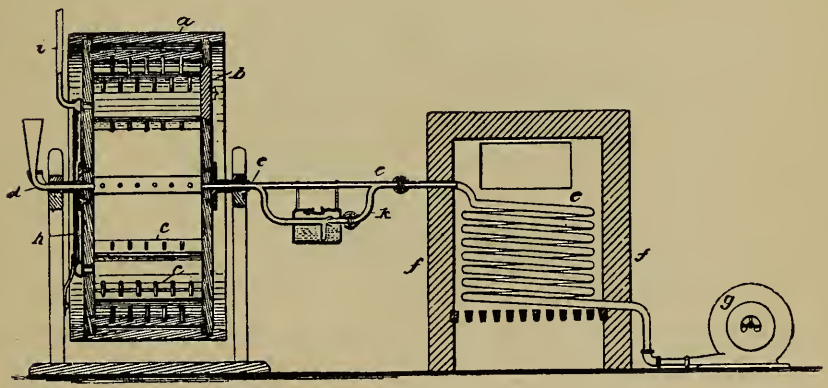
The leather to receive grease or stuffing is usually placed in a rotating drum or wheel previously heated by steam or hot air blown into it while the wheel is empty, for it has been found that steam injected into the drum in the presence of the leather is apt to burn it. A drum heated only before placing the leather in it commences to cool immediately thereafter, and the stuffing or greasing operation is retarded. Another serious objection to the direct introduction of steam into the drum with the leather and grease is that arising from water of condensation, as even a small amount of water added at that time, the leather having been evenly and sufficiently moistened before it was placed in the drum, will be taken up by the leather, thus lessening the amount of grease entering the leather at that spot where the water of condensation in the grease meets the leather, and, further, the heat derived from free steam varies materially, according to the pressure of steam in the boiler. To obviate the objection of free steam the drum has been placed in a second drum heated by steam.

In this invention the interior of the drum and leather therein are kept at the desired temperature by means of heated air forced therein while the drum containing its charge of leather is being rotated. The hot air is supplied to the drum by a blower or pump through pipes, in connection with a receiving-chamber of a suitable heat-generating apparatus.

Figure 58 represents, in vertical section, an apparatus embodying Reed and Winchester's invention, the wall of the heat-generating apparatus being also in section. Fig. 59 is an elevation of the left-hand end of the drum, the latter being partially broken out.

The drum, *a*, about seven feet in diameter, has a door, *b*, for the introduction of the leather therein, and a series of pegs, *c*, at suitable intervals apart to lift and tumble the leather as the drum is rotated, all as usual. This drum has at one journal a pipe, *d*, for the introduction at suitable times of hot grease, and at its other journal it has a pipe, *e*, for the continuous admission of hot air while the drum is being rotated with the leather and grease therein. The pipe *e* is preferably placed, in coil or other form, in the combustion-chamber *f*, heated in any usual way, so that air forced through the pipe by an air-forcing apparatus,

FIG. 58.

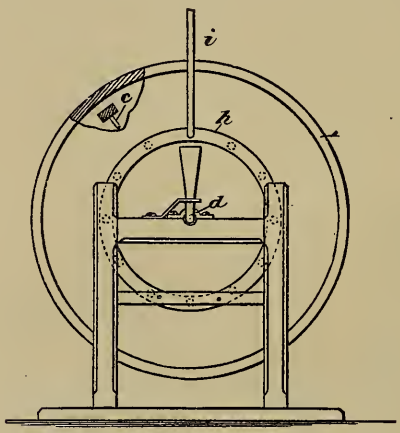


g (shown as a blower, but which might be a pump), will be heated before reaching the drum. The side of the drum will be provided with openings of suitable size for the escape of the heated air, so as to maintain proper circulation. The air so escaping might be delivered into an annular chamber, *h*, placed next to the openings of the wheel (see Fig. 58), having a pipe, *i*, to lead the air out of the building, if desired.

The air-pipe, at a point between the chamber *f* and drum, may have a branch, *k*, by which, if desired, to divert the heated air into a water-box and over a pan of water, to thus add a little moisture to the hot air, if too dry; or we may inject a small amount of steam into the pipe *e* containing the hot air, to slightly moisten it, care being taken to so regulate the steam that no water of condensation is permitted to form or enter the drum.

In this process it is possible to keep the interior of the drum and the leather therein at a uniform temperature, which may be

FIG. 59.



indicated by a thermometer properly connected with the drum, which enables the leather to be greased or stuffed uniformly and rapidly, and that without fear of injuring the leather in any way by over-heating, as when steam is depended upon, or by too rapid cooling, as when the drum is heated only before applying the leather. The grease, in proper quantities, can be introduced from time to time, as needed.

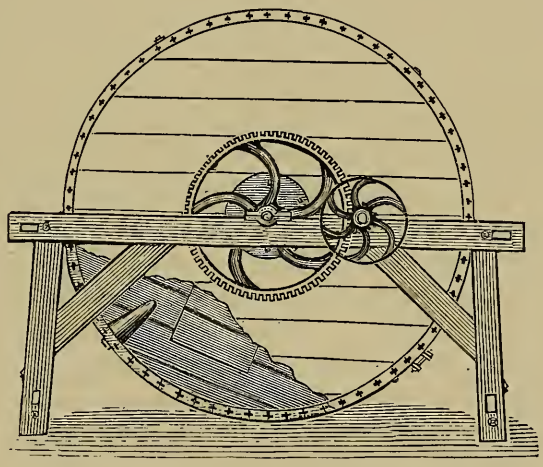
This valuable invention appears to have been suggested by that of Dr. Friederich Knapp, of Brunswick, Germany, who invented an improvement in tramping-drums in 1878, which possessed the combination of the drum and hollow trunnions and

the blower or fan and other arrangements very similar to the stuffing wheel which has just been described; but while our Government granted Knapp a patent for the fan attachment to the stuffing wheel, the German Government had previously refused it as not being a new idea.

FREEMAN'S STUFFING DRUM.

J. T. Freeman & Co., Woburn, Mass., manufacture all kinds of stuffing and tanning drums, driven either with a gear on the outside or on the end, as shown in Fig. 60, as parties may desire.

FIG. 60.



The machines made by this firm are all put together in the best possible manner, and are in every way fitted for the work required of them, and they offer them to the trade, feeling that they will prove completely satisfactory, and they guarantee them to be in all respects as represented. Their machines are in use in the establishments of nearly all leading tanners and curriers in the United States.

CURRIERS' OILS AND GREASE.

Oil is the general name for a class of bodies which have all

or most of the following properties in common: They are neutral bodies, having a more or less unctious feel and viscous consistency, are liquid at ordinary temperatures, are lighter than water, and are insoluble in it, but dissolve in alcohol and more readily in ether, and take fire when heated in air, burning with a luminous, smoky flame.

The name oil is made to embrace three distinct classes of bodies: 1, fixed or fatty oils; 2, volatile and essential oils, and 3, petroleum and other mineral oils. The first class comprises a number of organic bodies, composed of carbon, hydrogen and a little oxygen, viscid liquids, communicating a permanent stain to paper, insoluble in water, and as they occur in nature, mostly mixtures of different simple fats, which, by saponification, are resolved into fatty acids and glycerine. The term fat is applied to these oils when they are in a solid state; thus the same product may be an oil in one climate and a fat in another. The second class, volatile and essential oils, consist either wholly of carbon and hydrogen, or of these elements supplemented by less proportions of oxygen, nitrogen and sulphur. They have a thin, oily consistence, volatilize completely at a high temperature, possess powerful and peculiar odor and flavor, and are very inflammable and sparingly soluble in water. Many of them occur ready formed in organic bodies, chiefly of the vegetable kingdom, and are then true essential oils; others, which are volatile but not essential, are produced by dry distillation, fermentation and other changes. The third class, mineral oils, belong strictly to the preceding, being truly volatile oils.

In a fresh state the fats are odorless, tasteless, colorless or white bodies, which may be either solid or liquid. They are insoluble in water and cold alcohol, but dissolve freely in ether, chloroform and benzine. The solid neutral fats, like spermaceti, suet and lard, and the liquid non-volatile oils, like sperm and olive oil, are classed together as fats. They are compound ethers formed by the union of fatty acids with the triatomic alcohol glycerine. They are composed of carbon, hydrogen and oxygen, but contain no nitrogen.

The most common and abundant are stearin, palmitin and olein. Of these, stearin and palmitin are solids at ordinary temperatures, and olein is a liquid. Most animal and vegetable fats are mixtures of two or more of the simple fats, and their hardness depends largely on the relative quantity of olein or other liquid fat in them. When a fat is treated with an alkali, the fatty acid unites with the alkaline base, making a soap, and glycerine is set free. When a soap is treated with an acid, the base is taken from the fatty acid, which is thus set free.

Neither essential nor mineral oils can be spoken of as fatty substances. So far as these are of interest to tanners and curriers they will be here described.

For leather there is probably no oil that combines so many points of excellence as strictly pure cod oil, which is obtained from cod liver, and is produced in quite large quantities, and has stood the test of experience and trial for a very long period of years, dating back to the earlier stages of the leather industry.

The reasons for the excellence of cod oil for leather purposes are not hard to find.

In the first place, it has a splendid body, and imparts to the leather a permanent mellow feeling, by reason of its freedom from oxidizing (caused by absorption of oxygen from the air) common to a great many other oils.

Cod oil absorbs oxygen, or in other parlance, gums, to the smallest appreciable extent only, and for that reason, together with its great body and freedom from evaporation, remains in the leather under the same conditions practically, in which it was originally put in.

The best quality of cod oil comes from the Newfoundland Fisheries, where the method of extracting the oil from the liver in a cool atmosphere, extracts only the cream of the oil, which is very rich and contains the minimum of animal fibre, blood, gluten, etc., thereby insuring the very best results.

This oil commands the highest price in the market, and is worth the difference in cost between it and cheaper grades, or any adulterations.

Some of the adulterants used by unscrupulous dealers are mineral oils of various kinds, including paraffine oil, as well as brown seal and menhaden oils.

Cod-liver oil is a valuable oil afforded by the liver of several fish of the genus Gadus, notably that of the common cod. The chief seats of the cod-fishery are the coasts and banks of New Foundland, Nova Scotia, the Gulf of St. Lawrence, the west coast of Norway, from Stavenger nearly up to Hammerfest, and including the Loffoden Islands; the coasts of Denmark and Germany, commencing at Romo on the west, passing through the Skager Rack and Cattegat, and extending east to Dantzig; the coasts of Shetland, Faroe and Iceland, the Dogger Bank in the North Sea, and the most prolific of all, the shores of Alaska in the Pacific Ocean. The most usual classification for cod-liver oil is into 1st, steam-boiled medicinal or ordinary bright; 2d, an inferior "light brown," and 3d, the "dark brown" or "tanners'," obtained by roughly boiling down the livers remaining after the other two oils have been extracted. The best is said to be from New Foundland. The chemical and physical characteristics of the 3d grade, the only one in which we are interested, are as follows: The color is dark brown, greenish by transmitted light; specific gravity 0.929, at 63½° F.; soluble in 17–20 parts cold or hot absolute alcohol; deposits no solid fat at 90° F. The oil consists chiefly of oleine and margarine, and contains small portions of iodine, bromine, and free phosphorus, besides peculiar constituents. Many other oils are substituted for true cod-liver oil. That obtained from the ling, the liver of the dorse, and of the coal-fish, the barbot, the haddock, hake, cat-fish, conger eel, ray, shark, and probably many others, are surreptitiously mingled with the cod-liver oil of commerce.

Genuine cod oil is made wholly from the liver of the fish, while menhaden oil is squeezed from the body of the fish. The latter oil has more gum or glutinous matter than the genuine cod oil. Mineral oil improves it by cutting the gum, and this is the reason that cheap cod oils are often used without

trouble. Cod oil and menhaden oil are of the same color and gravity, and resemble each other as to odor and taste. These similar properties make deception very easy. A better and more economical way than to buy cheap "cod oil" is to buy pure pressed menhaden oil and buy paraffine oil and combine the two oils in the proportions wanted. The pure cod oil is, however, everything considered, cheapest in the end. As long as dealers are determined to get large profits and tanners are deceived, the selling of cheap fish oils for cod oil will continue.

Mineral oils are easily detected by several well-known tests, such as the gravity test, as the admixture of mineral oils reduces its body or substance, and when compared with strictly pure oil, the difference can at once be seen. Another method of detecting mineral oil is by saponifying the fatty oil, whereby the mineral oil, which will not saponify, will separate. Another method is to distil off the mineral oil by heat of about 440° Fahrenheit, thus leaving the non-volatile oil behind.

Adulterations of brown seal and menhaden oils are almost impossible to detect chemically, but the bad effects will appear only after the leather has been finished, when it is too late to remedy them.

The only safeguard for the tanner is to obtain goods from strictly reliable houses only, of known reputation, and to take only such brands as are known to be strictly and absolutely pure and as represented.

Considerable quantities of cod oil are produced in the Provinces, and also from the various Fisheries in the United States, the general principle being that the deep-sea oil, made in a cool temperature, and thoroughly rendered, produces the best results.

Bank and Straits oils are used as substitutes for cod oil and for some purposes seem to answer very well. Both of these kinds are subject to absorption of oxygen, or in other words, gumming, when exposed to the air, Straits oil being a little lighter in color, and generally bringing one or two cents more per gallon.

Degras, the imitation variety, is a wool grease, reclaimed from washing of wool, and varies in excellence owing to the kind of wool washed, the method of saponification or scouring soap used in the process, and thirdly, upon the method of recovering the grease.

Where either of these methods is poor, the resultant grease is bad. There is therefore quite a range in price to correspond with the different qualities.

Some degras is not fit for use on leather, as it is imperfectly made or not properly purified.

Large quantities are imported into the United States from England, France and Germany, but great care should be exercised to secure the proper goods in order to obtain the best results. The true degras comes from France.

It is safer to use only the best and well-known brands, which are carefully and uniformly made, and are by test and experience known to be of uniform quality and excellence. Among such reliable goods, which have been on the market and most favorably known for a great many years, are the "Anchor" and the "Merino."

English sod oil is a product resulting in the oil tannage of skins, which are allowed to heat slightly by exposure to the atmosphere in moderately warm temperature, and the excess of oil is thereafter pressed out, or washed out with a weak alkali, as the case may be, some employing both methods and some only one in extraction; but as a rule, both are used, and the resultant oil makes the sod oil of commerce.

It will be at once apparent that there is an opportunity for a great variation in quality of sod oil, dependent upon the methods employed, the kind of skins treated, and the kind of oil originally used for tanning. Therefore, the currier must be careful to buy only those kinds that he knows are adapted to his particular finish if he would get the best results.

Some of the sod oil is boiled after having been expressed from the skins, and the water evaporated out. Other brands have more or less water in combination.

It will therefore be seen at once that here is a chance for wide variation in price, to correspond with the difference in quality. Therefore the experienced purchaser or handler can by selection suit the individual currier with such goods as he may require.

French moellon oil, strictly speaking, is an expressed oil from chamois tannage, French degras being a mixture of moellon and oil obtained from washing the skins in an alkaline solution.

"Imperial" French moellon is as good an article as there is on the market, and is always reliable and safe.

Tallow is not so generally used as formerly in the manufacture of upper leather, because other harder and dryer greases are obtainable, of strictly uniform quality, that seem to serve the purpose better. If tallow is used at all, only the harder and purer kinds, that contain no bone grease or other adulterations, should be used in order to get the best results.

Strictly pure rendered tallow, made from fresh fat, is by far preferable, as it is harder and contains less moisture than the ordinary cheap tallow rendered by steam.

Oleo-stearine, a product of the best suet tallow from which the oil has been expressed, is considerably used for stuffing of leather, and is a desirable article, although if used alone it does not give a satisfactory finish, being too dry and husky.

Paraffine wax should not be used in large quantities, because it has very little real body, its hardness being apparent rather than substantial. When melted, it is a very thin liquid, of extremely high gravity, and its apparent substance is due to the fact that it chills at about 125° F.

The principal stuffing used for upper leather is a brown, hard grease, made principally from rendered whitening and table grease, and this compound seems to give better results and produce leather of more uniform excellence than any other grease now before the public.

The reason for this is not hard to find, for the material is virtually a stearine, from which the oil has been absorbed in-

stead of pressed, thus making a desirable compound of the right body to thoroughly fill the leather, and at the same time make it mellow and good.

Competition has brought the price down to the lowest figure ever known, and the best brands are obtainable at prices nearly as low as ordinary tallow.

The "Ideal" grease probably combines as many points of excellence as anything in the market, and its use is rapidly extending, especially for split, grain and satin leather. In the manufacture of this grease comparatively new methods are employed, and the result is a scientific compound which produces the best stock at a minimum price. This grease is prepared by Frank L. Young and Kimball, Boston, Mass.

Neatsfoot oil is used largely in the manufacture of kid and skins of various kinds, and works very well if care is taken to secure oil that has been refined sufficiently to stand a first-rate cold test. Otherwise the skin is liable to turn white after being finished and exposed to a cold temperature.

A great deal of damage may be done by using impure or imperfectly manufactured oil, and great care should be exercised in getting the right kind of goods.

The Vici brand of neatsfoot oil is a well-known brand which has stood the test of years and experience.

MENHADEN, STRAITS OR BANK OIL

A fish once eagerly sought for its oil on the Atlantic coast is the menhaden, pogy, mossbunker, bony fish, chebog, as it is variously called, (*alosa brevoordia menhaden*), a member of the herring family, about eight to fourteen inches long. The fishery is carried on all along the coast from Maine to Maryland. The fish leave the Gulf Stream and strike the coast of New Jersey in April, reaching the coast of Maine in May or June, and remaining till October or November. They migrate in enormous schools and are caught in seines. These fish are nearly all boiled down to oil in steam kettles and exposed to hydraulic pressure; the scrap being utilized for fertilizers. The

oil is clarified and bleached by boiling and filtering. Thus refined it is called "straits." Bank oil is an inferior grade. Bleaching the oil is done by exposing it to the sun in glass-covered shallow tanks. Owing to the tendency of menhaden oil to gum, it is not much used now in the leather industry.

PORPOISE OIL.

Porpoise oil embraces the oils obtained from the black porpoise, the white whale, the grampus and the blackfish. A full grown porpoise attains a weight of 2,500 to 4,000 pounds, and gives some 400 to 450 pounds of oil, which is more esteemed than that of either the seal or walrus. These animals are taken by being surrounded by enclosures made of light flexible poles driven into the beach, within which they are speared and harpooned from boats. The oil is inodorous and gives a brilliant light, it congeals only in intense cold, and its softness renders it valuable for lubricating and leather dressing.

The oil obtained from the head of the grampus is thought to be even superior to any yet obtained from the porpoise and the black-fish, but this cetacean occurs much more rarely than either of the animals just described.

TUNNY OIL.

The tunny is second in importance only to the sardine among the fish caught in the Mediterranean. This fish yields a very large quantity of oil which is extracted by boiling, which operation is performed in the crudest possible manner. Tunny oil is of a pale amber color, and possesses more body than any other fish oil. It is very commonly adulterated with inferior cod oil and cotton-seed oil. That prepared at Genoa is said to be superior to all others.

NEATS' FOOT OIL.

Neats' foot oil is made from "ox feet," the feet and hocks of neat cattle cut off about eighteen inches above the hoof, and is a valuable oil. It is prepared by denuding the feet of skin

and slitting up longitudinally, by a knife passed between the sections of the hoof and continued between the long bones. Near the hoof is a small mass of soft fat, which is scooped out with a knife, and set aside for the preparation of the best quality of oil. The hoofs are washed in cold water and then boiled. A certain quantity of oil is thus boiled out of them, and when skimmed off, forms an inferior grade of neats' foot oil. After about three hours' boiling, the tissues between the horny hoofs and the last digit bone are sufficiently softened to allow of the latter being easily scooped out of the hoof with a knife. These "cores," consisting of bone, gelatinous matter and fat, together with the small pieces previously alluded to as being removed by the knife before boiling, are put into a separate pan of fresh water, and all boiled together for the extraction of the oil. This forms the best kind of neats' foot oil. The oil is usually yellowish or greenish in color, but that from Buenos Ayres is often colorless. It is odorless when fresh and of agreeable flavor. It is limpid and remains so below a temperature of 32° F. Its density at 59° F. is 0.916. On standing for a short time, a proportion of solid fat separates out, and may be filtered off. It is very rarely found pure.

DEGRAS.

We have only to speak now of degras, the surplus oil from the chamois leather manufacture, which, in France is prepared by daily stocking the skins with oil, and hanging in the air for oxidation. The degras is obtained not by washing the skins in an alkaline lye, as in the English and German method, but by simply pressing or wringing. This oil, altered by oxidation, is so valuable for currying purposes that skins are frequently worked simply for its production, being oiled and squeezed again and again till not a rag is left. It is generally mixed in commerce with more or less of ordinary fish oil. Eitner recommends, where the degras is of indifferent quality, a mixture of 65 parts degras, 20 of neutral soap (i. e. soap without the usual excess of alkali), and 15 of soft tallow.

A degras is used in England called Vickers' degras. It is more softening than sod oil, and carries the tallow well into the leather. Hides left in it for some time are not darkened. If stearine is used, 20 to 35 per cent. of degras obviates harshness, and goods will be firm yet mellow. In cheap lining bellies, this degras, used instead of cod oil, gives better weight, lighter color, and a good "calf" handle. It is much cheaper than French degras.

The use of sod oil or French degras, for stuffing bark-tanned leather, dates as far back as the last century. At that time curriers used it mainly in the form of "fat liquor," although a considerable quantity was also used as "sod oil." At that time sod oil was made from fat liquor by decomposing the same with alum; otherwise the process was the same as to-day, where sulphuric acid is used to "throw out" the sod oil. The use of sulphuric acid offers no advantage over alum except being a little cheaper, while on the other hand, sulphuric acid is a very dangerous enemy to leather. If the acid used for making sod oil is added even in small excess, it will be carried with the sod oil into the leather and there surely work havoc. Leather stuffed with such sod oil is very liable to get tender, and logwood black will be apt to fade if sulphuric acid comes in contact with it. We have tested numerous sod oils which contained quite a considerable quantity of sulphuric acid. It is often thought that heating a sod oil will drive off any sulphuric acid. This notion is erroneous, as sulphuric acid is not volatile below 590° F., and sod oil at this temperature would be burned to charcoal. The only practical way of getting rid of an excess of acid in sod oil is to boil it with a weak solution of soda or other alkali. The alkali will combine with the acid and leave the latter powerless to do any damage. When French calfskins had become renowned for their superiority, it was found out that the principal factor of their stuffing consisted in French degras (sod oil). Curriers in other countries began to imitate the French, and soon found that they got a superior article of leather by using French degras in combina-

tion with other greases. The method used in France for tanning oil-dressed leather, and for making sod oil, differs radically from that in use in other countries. The French proceed about as follows: After the usual beam-house operations, the skins intended for chamois leather are oiled on the table with fish or whale oil and folded in cushions. The cushions are now subjected to the action of the fulling mill for an hour or two, then hung out in the open air to cool off, from one-half to one hour, and after piling in a heap for a few hours they are again fulled. These operations are repeated for several weeks, giving the skins an occasional oiling off between the fullings. After being completely tawed the skins are generally soaked in fish oil for a short time and then put in presses to squeeze out the surplus oil that has not chemically combined with the fibre. This surplus oil constitutes genuine French degras. If the production of French degras be the main object, poor skins are taken and the above process of fulling, etc., and pressing out the oil or degras, is repeated. Thereby a second, third, etc., quality of degras is produced. In fact there are a number of establishments in France and Austria that do not produce any oil-dressed leather, but which manufacture only French degras. These factories use only poor skins and offal and keep on tawing the same and pressing out the degras, until only a few shreds and fibres are left of the skins. Genuine French degras has the appearance of thick oil and is perfectly liquid, so that it can be poured from one bottle to another with ease. It contains no product of saponification or alkali of any kind. In speaking of the different processes of oil-dressing we shall call that used in most European countries, except France, simply the European. The process generally used in this country and that used in Europe, differs radically from that in use by the French. In the American, as well as the European, process of oil-dressing the skins go through a heating process, which heating changes the sod oil in the skins from a thin fluid oil to a thick, viscous mass. In this country the skins, after leaving the beam-house, are oiled

off and then milled for about an hour and hung up for a short time to cool, and then milled again, etc., as in the French process. After being completely tawed they are hung in a hot room until they are thoroughly heated and completely dry, and are put through a last milling and heating process called "milling off." During this "milling off" the skins become very hot, and care must be taken that they do not scorch.

The European method of oil-dressing is again different from the American and French processes. In the European process of chamoising the skins, after leaving the beam-house, they are oiled off, and three to four skins made into a cushion, and these cushions are milled for three to four hours. After oiling off they are again milled, and after getting a third oiling they receive another milling; after which they are hung in the air a short time to evaporate a part of the moisture in the skins, and the process of oiling and milling is then continued. Sheep-skins require six to eight oilings and millings to be completely tawed; hides ten to twelve. After being sufficiently tawed, the skins are put through a heating much more intense than is customary in this country. The heating or fermentation causes the oil to oxidize and thicken. Consequently, the longer and more intense the heating is conducted the thicker and more viscous will be the resulting sod oil. Thus we find the genuine French sod oil fluid. The American is so thick that it cannot be poured from one vessel into another, and the European sod oil is a mass almost as thick as dough. In their specific action on leather there seems to be very little difference. We would remark that the description of the properties of the different sod oils pertains only to natural sod oils made according to the processes as described, and not adulterated with foreign oils. Owing to this difference in their physical properties, the American and European sod oils are recovered from the oil-dressed leather by washing with an alkali solution and decomposition of the fat liquor with sulphuric acid; while the French sod oil is recovered by simply pressing or wringing out the surplus oil. It would be found a very tedious job to make sod oil in this coun-

try by simply pressing the oil out of the leather, owing to its heavy body. It was, until recently, believed that the fish oil used in oil dressing was changed to sod oil by oxidation. This theory seemed very plausible for several reasons. Heat is always liberated by milling with oil, and the only properties of genuine sod oil that were generally known, viz.: the specific odor and the property of not gumming with water, could be given to fish oil by artificial oxidation. But the most valuable and characteristic property of genuine sod oil has never yet been produced artificially, and this property is the tanning principle of pure sod oil. Pure sod oil contains from 15 to 20 per cent. of a substance that will chemically unite with the fibre of partially tanned leather, or with raw hide which is stuffed with it. This substance, when separated from sod oil, is a dark brown, brittle body, resembling in its appearance dry hemlock extract. The tanning principle of pure sod oil is the cause of the high esteem in which it is held as a leather stuffing; and there is no doubt that it is this substance that gives to sod oil different properties from the ordinary oils and greases, making it so valuable to the currier. Therefore, artificial sod oil, if of good quality, while possessing some valuable properties lacks the most important one of natural sod oil. The tanning principle present in natural sod oil effects a retanning process in leather stuffed with it, at the same time imparting to it that velvety feel peculiar to leather stuffed with natural sod oil. If, therefore, leather which is not sufficiently tanned, be stuffed with grease containing a percentage of real sod oil, it will undergo a retanning, and a nice mellow product will be obtained, which, otherwise, would not have been the case. Besides real sod oil, the only oils or grease known which contain a small percentage of this tanning principle, are the fish oils.

Menhaden Bank and Straits oils contain usually about one to five per cent. of tanning principle. One sample of genuine cod oil, which, by the way, is a very scarce article, contained seven per cent. of tanning principle, while other samples of so-

called cod oil, analyzed by us, did not show much more than Menhaden Bank or Straits oil. The value of fish or cod oil as a leather lubricant is largely dependent on the amount of tanning principle contained therein, and an oil containing eight per cent. of this substance is really cheaper at thirty-two cents than another oil with one per cent. tanning principle would be at twenty-three cents. Again, very many cheap fish oils may be better suited for oiling and chamoising leather than a high priced cod oil. We have tested a number of samples of cod oil that did not contain more than one and a half per cent. of tanning principle. Another point of interest is the fact that fish oils, rich in tanning principle, are much less liable to "gum" than those which contain a smaller percentage of this substance. More than one-half the sod oils sold in this country are either wholly artificial or they contain but a small percentage of natural sod oil, and do not contain more than two to five per cent. of tanning principle. We therefore claim that about the same results could be obtained if a good fish oil was substituted for such artificial sod oil for stuffing leather.

PARAFFIN WAX.

Paraffin wax is a mineral product destined to largely displace tallow and oleo-stearine in the manufacture of wax upper kids, calf skins, oil grains and harness leather.

It is but a few years since paraffin wax, a by-product of paraffin oil, was introduced as a substitute for tallow, oleo-stearine and other heavy greases, in the manufacture of leather. Like all innovations, it met with decided opposition from tanners educated to the belief that animal greases are the only suitable ingredients for "stuffing," or filling the pores and cells of leather, thereby rendering the fabric practically waterproof, as well as producing that supple and greasy finish so desirable for the boot, shoe and harness manufacture.

Paraffin wax has all the filling properties of oleo-stearine, together with other good qualities of its own. It will not evaporate by long use; it will not dry or gum by exposure to

the inclemency of the weather, and it can be melted at a temperature of 124 to 126 degrees F., in connection with tallow or degras. At this temperature the greases are readily absorbed, if the stuffing wheel is employed. Indeed, the stuffing wheel is the only practical method of forcing heavy greases into the pores and cells of leather. As the tanners become more conversant with the filling and preserving properties of paraffin wax, they will be averse to paying for oleo-stearine, when the wax will give equal satisfaction, and at a lower cost.

Tanners, as a rule, are slow to adopt or even experiment with new materials, but within the past year, and largely due to the almost prohibitive prices of oleo-stearine, paraffin wax has been successfully introduced. We learn that it is securing a strong foothold in many tanneries. Where it has been accorded a fair trial, satisfactory results have followed, and there have at times been duplicate orders for car lots.

A tanner who keeps pace with the times must be constantly on the alert to secure tanning and finishing materials on a basis that will allow him to successfully compete with his neighbor, and without in the least deteriorating the quality of his produce. It has become necessary to look for economical substitutes for bark, oils, tallow, and, indeed, for all that enters into the leather manufacture. Oleo-stearine when first introduced to tanners was regarded with suspicion, because of the belief that all the best properties were extracted in the manufacture of butterine. The tanners have since learned that they cannot do without it, especially in warm weather, and the same may be said of the compounders of lard.

GLYCERINE.

The introduction of mineral salts in the manufacture of leather created many changes in the trade, and almost revolutionized the methods then in use for currying and finishing; many ingredients hitherto unknown were brought forward, amongst which was glycerine.

This article now takes a very prominent part, and that part

is after tannage to relieve the tension of the fibre of the stock, so as to take what other ingredients may be required to make it perfect leather, and at the same time to impart a feel to the leather that cannot be produced with any other fatty matter. It may be of interest to know how this article is produced. It is a liquid obtained by the decomposition of fats and fixed oils, and containing not less than 95 per cent. of absolute glycerine, a sweet principle, obtained from fats and fixed oils and containing a small percentage of water. It is a clear, colorless liquid of syrupy consistence, oily to the touch, hygroscopic, without odor, very sweet and slightly warm to the taste, and neutral in reaction. It is soluble in all proportions in water and in alcohol, also in a mixture of 3 parts of alcohol and 1 part of ether, but insoluble in ether alone or chloroform, benzol, or fixed oils. In proportions glycerine is intermediate between water and the oil; when exposed to the air it gradually absorbs moisture. Glycerine possesses great powers as a solvent, especially those of the chlorides of potassium and sodium of the alkaline earths. It also dissolves the vegetable acids, and particularly tannic acid. It is known that certain neutral vegetable substances are far more soluble in glycerine than in water. Glycerine does not evaporate when exposed to the air, nor can it be distilled without decomposition unless in the presence of water or steam. Pure glycerine is very essential where it is to be used on leather, and these precautions should be taken.

See that its consistency is up to standard, and that it is neutral (this can be ascertained by litmus paper). C. P. White 30° is generally used, and is by far the safest to buy.

From the time that the special property of glycerine of softening leather and rendering it supple became known, it has largely been used for oiling in the place of fat or degras. Although glycerine is capable of imparting to leather a high degree of softness and suppleness, it is incorrect to credit it with actual preserving properties. It is equally wrong to regard the suppleness it imparts to leather as a direct nourishment and strengthening. In this respect glycerine does not

replace the fats, which may be considered as direct nourishers of the leather, while the former, in spite of suppleness it imparts, also possesses a certain corroding, lixiviating alkaline effect. For this reason, glycerine, though advantageous its direct effect may be, should never be used alone for oiling and softening leather, the more so as wet and humidity will readily wash it out, whereby its influence is rendered nil; besides this, when the glycerine is expelled it also carries away certain softening constituents of the leather itself, which had partly become dissolved in the glycerine, thereby leaving a leather that has become to that extent harder. This is the more worthy of attention, as it is quite frequent that glycerine rubbed into leather is expelled from it by the influence of wet; and although the use of this unguent has become a custom everywhere, the currier should avoid using it alone for oiling leather, but mix it previously with supplementary ingredients—in other words, prepare it first in a corresponding manner.

Glycerine of itself is wanting in the proper power of binding it to the leather, which is due to its exceedingly great solubility in water. Attempts were formerly made in practice to correct this want by previously rubbing the leather slightly with glycerine, and then, as it were, giving it a more substantial covering of melted tallow, but in this procedure the effect of the glycerine was only small and simply of a secondary nature. In order to correct the want of the binding power of glycerine, if not wholly at least largely, the currier must seek to principally neutralize its very great solubility in water. This can naturally not be done altogether without partially changing the nature of glycerine, and of course, also its softening effects. Still a better adherence of the glycerine to the leather can be brought about thereby.

This may be effected in two ways. According to one, and doubtless the most practical way, a kind of artificial degras is composed with glycerine, by emulsioning it in a strong concentration, therefore as a very viscid substance with fatty bodies. As glycerine acts in a certain sense as a feeble alkali, similar to

a solution of potash, with which the degras is extracted from morocco-tanned skins, it can readily be rubbed together with a mixture of fish-oil and beef tallow, and emulsioned with it. The desired quantity of beef tallow is first dissolved in heated fish-oil, the mixture is well stirred together and permitted to congeal to a butter-like consistency. To the soft mixture of fats is then added about one-quarter of its weight of glycerine, and intimately incorporated with it, so that the mass is finally of a cream-like condition. This glycero-degras enables the currier to obtain the same advantages as from lubricating with fat or glycerine alone.

Glycerine may also be fixed in the leather by preparing it with substances which will dry out, and thereby lose their solubility in part, and, of course, neutralize this in a measure in the glycerine. For this purpose it might be recommended to mix glycerine with egg albumen, rubbing together, but always in such a proportion that the latter is present only in a very small quantity. This imparts to the non-drying glycerine a certain fixing basis, which again thereby preserves its greatest virtue of imparting suppleness. This prepared albuminous glycerine may either be used alone, or else serve as basis for the previously-mentioned glycero-degras.

In cases when such a trifling addition of albumen should appear too costly, glycerine may also be mixed with a small quantity of dextrine solution—an addition that is decidedly a defective one, still it answers its purpose to a certain extent.

The combination of glycerine with tannin may also be regarded as a special preparation. A corresponding quantity of extract of oak-bark or other tannin is by boiling dissolved in glycerine, which is easily done, and in this way it becomes a very valuable fat for lubricating the hide; the good effects being still increased by emulsioning this tanninous glycerine in the above-explained manner with fish oil and tallow, and converting it into a degras.

A practical method of stuffing with glycerine is described as follows: The leather is treated with a mixture of tallow, degras

or fish-oil, and glycerine, instead of with the ordinary stuffing grease. As glycerine combines well with water, the stuffing is readily absorbed, and the glycerine very evenly distributed, which not only adds substance, but makes the leather exceptionally soft. After the leather has been blackened, and while only partially dry, glycerine may again be worked into the grain side, followed by a coating of wax; this prevents the glycerine from working out on the surface and gives a drier feel. The method described gives a pleasing dull lustre to the leather.

From the preceding it will be seen that although glycerine possesses certain advantages, it has also great defects, which can be corrected only by suitable preparation and admixture of other substances.

TESTING OILS.

Oils, degras, grease, etc., are difficult to judge, as to their real honest value. To those inexperienced in testing and tasting cod oils, etc., inferior goods are not much unlike the better grades. And it is well known that excellent leather may be spoiled and damaged in finish and appearance by the use of adulterated materials, skilfully compounded and sold at low prices which attract unwary buyers.

There are few commodities sold in which adulteration is practiced more than in oils, as tanners and curriers know to their cost. We suggest the following simple tests:

Apart from the test for determining compound oils, there appears to be no other except a chemical test, and that is unsatisfactory. To determine the amount of compounding, take a two-ounce vial and fill it half full of a very strong alkaline solution—ammonia, caustic soda or caustic potash. Fill the vial nearly full of oil and shake thoroughly. Mineral oil will not make soap, and will separate. Any animal or fish oil will mix with the alkali, and from its color can be told the compound and the percentage of the same. Neat's-foot oil will be yellow, but tallow and most other oils will be of different shades

approaching white. Lard oil will be whiter than tallow. The test will show sperm oil to be composed of about two thirds of paraffin oil. Lard oil is similarly adulterated. This test does not show the "stock" from which the oil is made, nor whether the animal acids have been extracted from the animal oils. These should have the acids extracted, which honest oil dealers now can do.

The evil effects of the bad conditions of fats generally do not show themselves until the leather is finished and probably out of the hands of the tanner. The worst of these defects is the gumming and exudations due to the excess of acids in the oils, tallow or degras. The blame is not always due to the seller. The free acids increase in stored oils, and so it is quite possible that an oil which was of very good quality when bought may become almost worthless from excess of these acids by the time it is used. To distinguish a genuine degras from simple fat emulsions, the latter being generally sold at a higher price than the former, chemists nowadays generally resort to an estimation of the degras former. The most usual adulteration was found to be cheap wool fat, which if present in any quantity will give leather liquored with it a sticky feeling, which is the reason that wool fat cannot be used in tanning. In tallow the principal adulterant found is cotton-seed oil. Rancid tallows which spew out on leather are frequently found.*

* For exhaustive treatises on all the oils, the reader is referred to the following books:

Brannt. Petroleum: Its History, Origin, Occurrence, Production, Physical and Chemical Constitution, Technology, Examination and Uses; together with the Occurrence and Uses of Natural Gas. Edited by William T. Brannt; Philadelphia, Henry Carey Baird & Co., 1895. Price, $7.50.

Brannt. A Practical Treatise on Animal and Vegetable Fats and Oils: Comprising both Fixed and Volatile Oils, their Physical and Chemical Properties and Uses, the Manner of Extracting and Refining them, the Practical Rules for Testing them; as well as the Manufacture of Artificial Butter and Lubricants, etc. By William T. Brannt; second edition, revised, 2 volumes; Philadelphia, Henry Carey Baird & Co., 1896. Price, $10.00.

BORAX.

Borax, in addition to being used for softening water used in the soaks, and in the leaches for extracting tannin, and for washing hides and skins previous to placing them in the tan liquor, is also employed for cutting the oils and fats used in stuffing leathers. Sal soda, chip, soaps, and soapine and other alkalies are also used for the same purpose.

STEAM JACKET KETTLES.

E. B. Badger & Sons, Boston, Mass., coppersmiths, manufacture steam jacket kettles and copper work of all kinds for the tannery and currying shop.

STUFFING OR FAT LIQUORING WITH PALERMO FIG SOAP.

Many tanners find great difficulty in properly stuffing or fat liquoring the leather after it is tanned. This is due to the fact that many people consider this operation a comparatively unimportant one, believing that if the leather is properly tanned the subsequent processes will regulate themselves accordingly.

This is a mistake, as the precipitation of fatty or oleaginous bodies in the fibre of the skin is an operation requiring as much judgment, skill and knowledge of materials used as any division in the complex art of leather manufacture. The great desideratum in all fat liquors is a soap which will combine readily with the other ingredients and enter into combination with the mineral salts, or tannins in the fibre of the skin, so as to render the finished leather soft, smooth and flexible without any traces of grease being left on the surface.

Of the few soaps which possess this valuable property we know of none so well adapted to the stuffing of all kinds of grain leather as that manufactured by F. E. Atteaux & Co. and sold under the name of Palermo Fig Soap.

This soap contains in itself all the properties of a good fat liquor, being rich in alkali without any excess of the same, and has the additional advantage of always being ready for use; thus dispensing with the labor of making up a fresh supply of

fat liquor for each batch of skins. Although it can be used as a fat liquor without any other ingredient, it also mixes readily with all the animal, fish and vegetable oils and also with egg yolk, and can be used in conjunction with them in any proportion.

It imparts a fine, glossy finish to the leather and fills up the pores and nourishes the skin to an extent that no other soap or fat liquor can equal. It dissolves readily in boiling water and can be applied to the skins at a temperature of 125° F.

FORMULA FOR MAKING FAT LIQUOR WITH PALERMO FIG SOAP.

Put ten pounds Palermo fig soap in a clean barrel with just sufficient water to cover the soap. Apply steam and stir constantly, until the soap is thoroughly dissolved. Now add to the soap bath four gallons of neats'-foot oil or cod oil (first cut the oil with a few ounces of borax, potash or sal soda). Stir for a few minutes until the oil and soap are thoroughly assimilated, then run in forty gallons of cold water to cool the emulsion. Then add ten pounds egg yolk and two pounds common salt. Stir the whole again, and apply to skins at a temperature of 75° F.

Twenty gallons of this fat liquor is sufficient to fat liquor ten dozen skins. It should be added gradually to the skins, and the quantity used can be varied to suit the tanner's judgment. It will give excellent results on any description of light upper leather or glove stock. The proportions should be changed, however, when it is intended for use on heavy calf skins, in which case it would be well to add to the oil and soap bath five or six pounds of French degras, and the amount of egg yolk may be reduced to five pounds.

In all cases care should be taken to cool off the soap and oil emulsion before adding the egg yolk, in order to prevent coagulation of the albuminous constituents of the egg which would result if the latter was added to water of a higher temperature than 75° F.

FAT LIQUORS.

It is hard to answer the query of "What is the best fat

liquor for chrome tanned leather?" as hardly any two manufacturers use the same formula. All the dealers in oils and fats have a fat liquor of their own make. The Martin Dennis Chrome Tannage Company, Newark, N. J., also make and sell a specially-prepared fat liquor, under the name of "Chromol." Some manufacturers have trouble in obtaining an even color on their skins—as they are spotted in places in the color.

There are various causes for this, but generally the fault lies either in the animal grease not being taken out or in too much fat liquoring. One of the most successful tanners, whose leather always shows a superior face and grain, sends all his skins after being blacked to a concern who take out grease by the naphtha process. Some manufacturers use a bath of water and borax for the same purpose. On receiving them back they are staked and recolored.

CHROMOL FAT LIQUOR FOR CHROME TANNED LEATHER—DIRECTIONS FOR USE.

Chromol may be warmed as it is and used as a hand stuffing for heavy leather; or may be dissolved in any proportion of warm water and used as a fat liquor, and milled into the leather by means of a pin mill drum.

Chromol imparts great softness, pliability and strength to the chrome leather without rendering the leather in the least greasy or gummy.

One special and desirable feature of this preparation is that it may be used on all fancy light colors without spotting or streaking the leather, a fact which commends it as a substitute for egg yolk.

For glove leather it is sometimes desirable to make a batter of flour and water and then add the chromol to the batter, and knead or mill the skins in the mixture.

WATER-PROOF STUFFING.

A good water-proof stuffing can be made as follows: Two and one half ounces of good drop black or vegetable black well ground in any suitable oil, ten ounces of castor oil, French second pressing, and eight ounces of tallow.

WATER-PROOFING LEATHER.

The process of rendering leathers water-proof, or impenetrable to water, has formed the subject of many patents; but with the exception of rendering leather impervious to water by the aid of mineral salts, we have not met with any compound that perfectly water-proofs leather, whether upper or sole, except the following:

As regards the mineral process, the formation of sebate of alumina or of iron in the leather, by first steeping the leather in a solution of soap and then in one of either of the above salts, has never yet proved its full title to be a perfect water-proofing process; and also the process of rendering gelatine insoluble in the pores of leather by means of an astringent, as alum, does not perfectly fulfill all the conditions necessary for rendering the leather so treated impervious.

As regards stuffing componds, which depend for their efficiency in filling the pores with some body, such as resin or wax, antagonistic to water, those compounds are far from good, because those of such compounds that cannot be extracted from the leather by heat may be eliminated by means of alkalies, which, by saponification of the resin or wax, render these bodies miscible in water. Compounds in which resin is the solid compound for filling up the pores of the leather to make it water-repellent can be converted into a miscible compound by means of sodic hydrate, while those compounds which depend for these water-proofing qualities on the wax as a component can be similarly treated by means of borax or borax and ammonia.

One of the most favorite compounds for giving leather the quality of water-resisting is paraffin wax, either driven into the leather by means of heat, or else by means of a solvent, as naphtha, benzine or carbon disulphide. But this wax can also be extracted again from the leather by either of these means; and if it be upper leather thus water-proofed, the lining of the boot made therefrom will become saturated with the wax if the boot be held in front of a fire; and again, if a spontaneous

solution of this or any other wax be used to impregnate sole leather, the wax will be eventually driven out of it by the pressure on the sole when the leather is made up into boots.

After trying some scores of formulæ for producing waterproof leather, we can find nothing better than these two. For sole leather: Warm the leather if it is oak or hemlock tanned and heat it if it is mineral tanned and brush it with a coat of copal or amber varnish; an oil varnish is better than a spirit varnish, as the former is more flexible, while for upper leather nothing is superior to this compound:

1 part by weight of raw gutta percha,
1 part by weight of paraffin wax,
2 to 3 parts by weight of benzine.

The gutta percha should be the raw, brown kind, not the vulcanized or colored kind.

To make this mixture, put the ingredients into a jar lightly covered with a plate and place this vessel near some source of heat where it will be very gradually raised to a warm temperature, but not enough to cause the benzine to vaporize, ignite or explode. Be very careful about explosions. After the solids have dissolved, stir the mixture and then, having rendered the leather warm, brush it with this solution, or else steep the leather therein until well impregnated, and then hang up to dry.

The compound, if properly prepared, will set semi-solid, and only requires to be reheated for use as above.

The advantage of this compound is this: Both the wax and gutta percha enter the pores of the leather in a finely-divided state and fill them up, while the volatile solvent eventually evaporates out of the leather, leaving the solids therein; now, neither of these bodies, wax or gutta percha, can be completely eliminated from the pores of the leather, because they are so thoroughly combined and in such a fine state that an alkali would fail to saponify the wax, and heat would fail to drive it out, because the gutta percha is worked in by the alkali, and

being so intimately impregnated in the pores, it is next to impossible to drive it out by heat; moreover, the gutta percha is a flexible body. And then this mass is an excellent stuffing compound for curriers' use in preparing water-proofed wax calf, satin hide, pebble grain, etc.

The author of the above says:

"I have tried this water-proofing compound on a score of different kinds of leather, and never found it to fail in rendering them absolutely impervious to water; and, moreover, so water-repellent that the leather will float in water for hours, sufficient proof that no water enters the pores; both these solid bodies are unacted on by alkalies, and thus I believe I can claim for this compound (one, by the way, which I have formulated after much research) the quality of being a perfect water-proofing compound.

"As regards colored leathers—tan, morocco, etc.—I advise one application only applied to the flesh side lightly, not sufficient to stain the leather through; but for upper leathers (kid excepted), the leather may be steeped in the compound, and wiped free of all superfluous drippings."

CHAPTER XVI.

SETTING-OUT.

THE method of setting-out described in the preceding chapter is not suitable for all classes of leather, but is for kips and skins or other light leather. Heavy leathers, such as harness and belting leathers, require a considerable amount of labor in setting, and it must be done in suitable condition if it is to be properly done. When available, the setting machine may be successfully used if skilfully applied, but in applying the same care must be taken not to distort the pattern of the hide, otherwise it will take the men who reset after the machine as long to regain a good pattern as the machine has saved; nevertheless, as above said, if the machine is skilfully applied it may be advantageously used in doing the most laborious part of the work.

The machine shown in Fig. 61 is built by the Vaughn Machine Company, Peabody, Mass., and is for stoning-out, scouring and setting-out, and is intended to be used for glove, satin and oil grain, wax and split leathers, etc.

This machine will remove the wrinkles from the neck, and will in every way smooth out and thoroughly prepare the side or hide for the belt knife leather-splitting machine. In fact it is invaluable for stoning-out rough leather for the leather-splitting machine, and far better results are obtained with it than can be had in any other way. The machines shown in Figs. 39 and 83 are also used for stoning-out; but the machine shown in Fig. 61 is used for large products of leather.

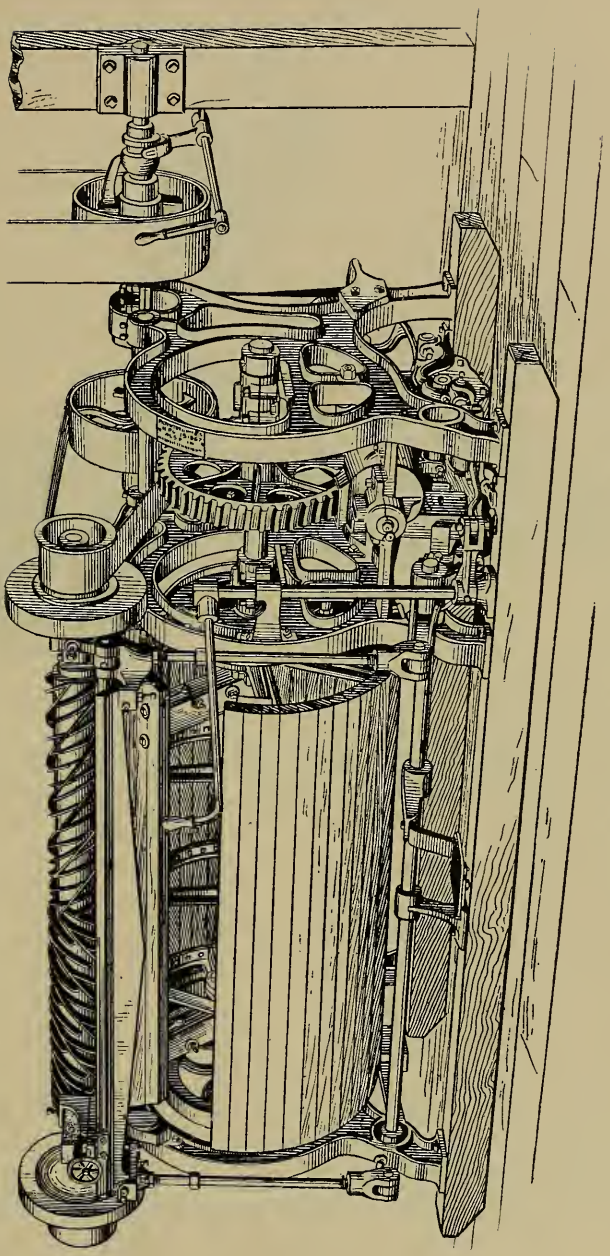


FIG. 61.

STONING-OUT, SCOURING AND SETTING-OUT MACHINE.

CHAPTER XVII.

WHITENING AND SHAVING LEATHER.

THE side having been stuffed and next "set out" (which latter operation can be performed for calf-skins or the heavier grades of upper leather by the machines shown in Figs. 58, 59 and 60), the next step in the process of manufacturing upper leather is that of whitening. This is usually accomplished by one of three ways: The leather may be placed on a table and whitened with a slicker, or cut over with a currier's knife on a beam, or the whitening can be performed by machinery.

FIG. 62.

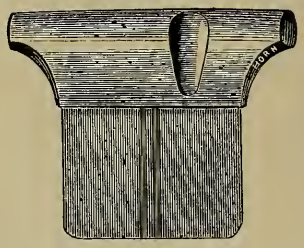


Fig. 62 shows the French pattern of whitening slicker, which is the kind usually employed in this country. The blades, which are of cast steel, are usually of two degrees of hardness; the bright blade compares in temper with a medium hard blade, the half polished are softer, being of a lower temper.

Fig. 63 shows the form of beam now generally employed in currying shops. The beam-bed and face are adjustable by means of screws, and the beam may be elevated or lowered at any necessary height to suit the convenience and comfort of the workman. The faces may be either of lignum vitæ or of glass.

There is a great variety in the construction of currier's knives; but the form shown in Fig. 64 is the most common. The blades are screwed in the brass jaws by three screws from each side, thus securing equal strength. The blades for the currier's knives are made of hammered steel, and are either bright or unpolished, and vary from seven-eighths to two inches

FIG. 63.

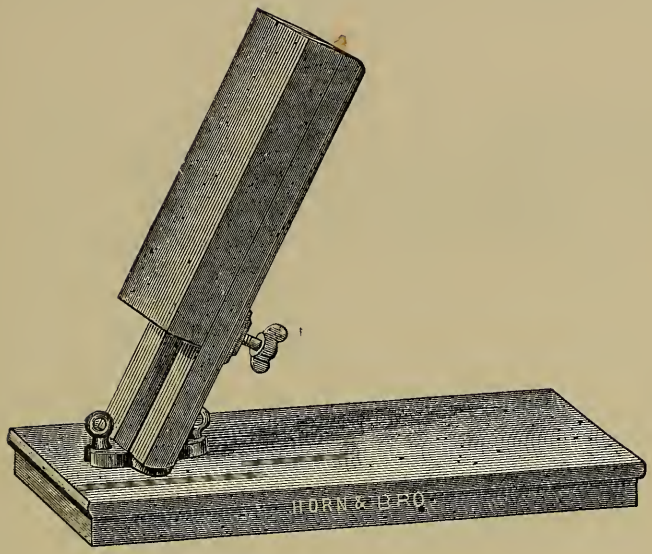
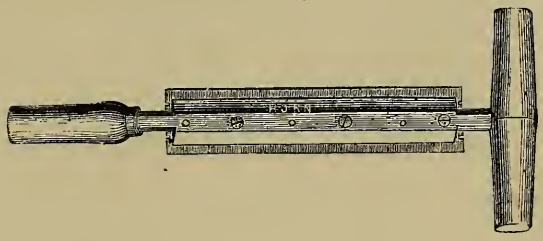


FIG. 64.



in width, and those kept in stock by the manufacturers are made in nineteen and twenty gauge, but other gauges are manufactured to order.

UNION WHITENING AND BUFFING MACHINE.

The Union Whitening and Buffing Machine, made by J. T. Freeman & Co., Woburn, Mass., is based upon the patents granted to Oliver C. Smith, of Ipswich, Mass., several later patents having been granted to J. T. Freeman *et al.* for improvements.

The machine for whitening and buffing leather invented by Oliver C. Smith is shown in Figs. 65 to 68.

Fig. 65.

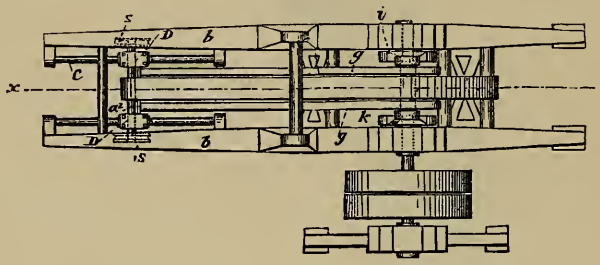


Fig. 66.

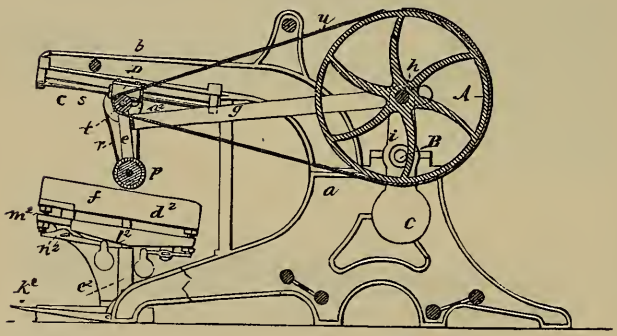


Fig. 67.

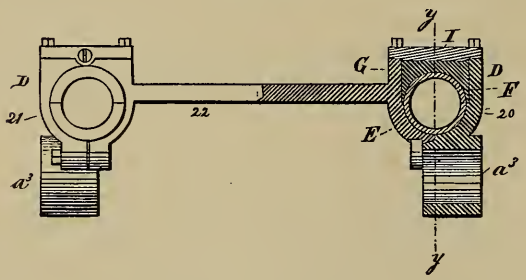
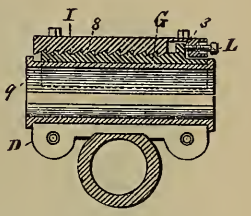


Figure 65 represents, in top view, a machine embodyiug Smith's invention; Fig. 66, a longitudinal vertical section

thereof on the dotted line *x x*, the table or bed being shown in elevation. Fig. 67 is an enlarged detail, partially in section, showing the boxes of the sliding frame; and Fig. 68, a section of Fig. 67 on the dotted line *y y*.

Fig. 68.

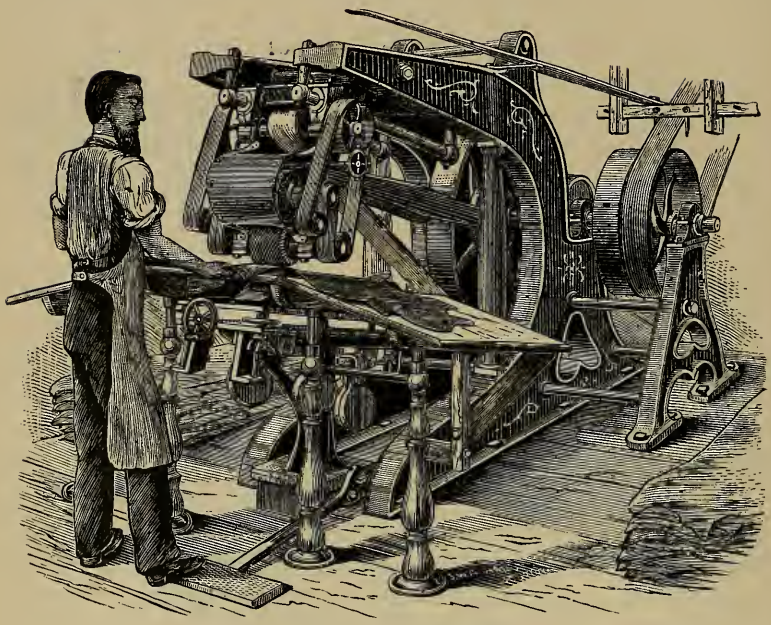


In this invention the pulley *A* is fixed directly upon the crank-pin *h*, joining the two cranks *i k*, projected from the shaft *B*. The weight of the pulley *A* is counterbalanced by the weight *C*, one on each crank. The belt *u* on this large fixed pulley *A* is extended over the pulley *t* on the shaft a^2 at the upper end of the usual swinging frame, and rotates the said shaft, together with its pulleys *s*, which by small belts *r* revolve the rotary cylinder or tool *p* in the usual manner as the link *g*, herein made double, reciprocates the carriage *D* on the guide-rods *c*. This carriage is composed of yokes 20, 21, connected by a bar, 22, the yokes having depending from them bearings a^3 to receive the shaft a^2, which turns in the said bearings. The boxes which run on the guide-rods *c* have Babbitt or other linings, *E F*. Upon the lining *F*, the inventor has placed an adjusting-wedge, *G*, provided with one or more inclined teeth or wedging-surfaces, 9, and above the adjusting-wedge he has placed a cap, *I*, having at its under side one or more opposed teeth or inclines, 8.

The machine, as at present built by J. T. Freeman & Co., of Woburn, Mass., is shown in Fig. 69.

This is the only machine ever put on the market that will whiten and buff successfully. It works the same on stuffed, greased or dry leather. It does the work equally as well as can be done by hand and takes off no more stock. It turns off a large amount of work and requires but a short time for an operator to learn to run it. Since purchasing the patents and patterns of the above machine J. T. Freeman & Co. have made a large reduction in the selling price of it and have placed it at a figure in reach of all leather manufacturers, in fact where they cannot afford to be without them. The machine occupies a space of about 10x5 ft. and is driven by a six-inch belt.

FIG. 69.



UNION WHITENING AND BUFFING MACHINE.

This machine is almost indispensable in a leather finishing shop, in fact we know of few machines which are so desirable and profitable.

SHAVING MACHINE.

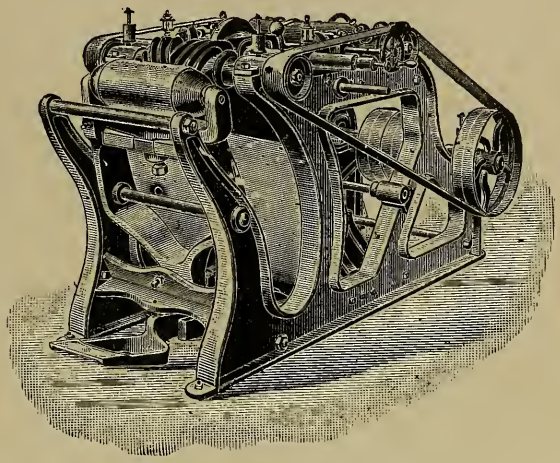
Fig. 70 shows the Rood improved shaving machine, manufactured by the Vaughn Machine Co., Peabody, Mass.

This machine is guaranteed to be a first-class machine in every respect for shaving the alum, acid and combination tannages. These machines are successfully used by the leading manufactures in shaving kip, calf, goat and sheep, and are acknowledged to do superior work to any machine or hand-work, and is used now almost exclusively for shaving by all manufacturers of leather.

The side frames and braces are planed and bolted together,

and are supported by a heavy bed-frame, thus making it impossible for the working parts to wear unevenly, by the working of the side-frames, owing to an unsteady floor.

FIG. 70.



ROOD SHAVING MACHINE.

The cutter is a new departure from all others now in use. The blades meet in the centre of the cylinder, and each pair have an extra cutter that cuts out the centre in advance of each other, thus allowing them to enter the skin to the depth of the cut they are to take.

With this improved cutter cylinder, the Rood shaver is able to shave the best quality skins and give the desired soft finish.

CHAPTER XVIII.

BLACKING LEATHER.

THE side of leather having passed through the previously described operations, and been last boarded is now in the state for blacking, and this is performed either by hand or machinery. It is thought by manufacturers that the hand process is preferable for the heavy grades of upper leather; but upon what ground it is not plain, as some of the machines constructed for this purpose are models of mechanism, and perform the work much more economically and thoroughly than is usually done by the hand process.

Figs. 71 and 72 show the two forms of blacking brushes in common use, and they are made both soft and stiff; the best quality are extra copper-wired, and are all bristle. The oval form is always made with a strap; but the round form has either handles or straps. Both brushes are made in first

FIG. 71.

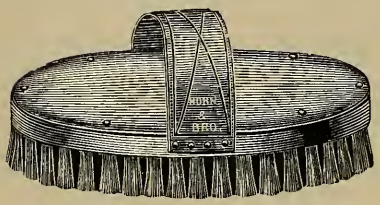
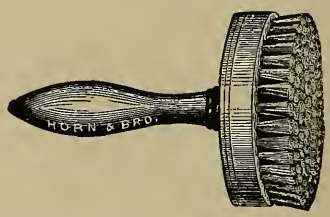


FIG. 72.



and second qualities; but it is economy to purchase the best made, as the extra wear more than compensates for the small difference in price.

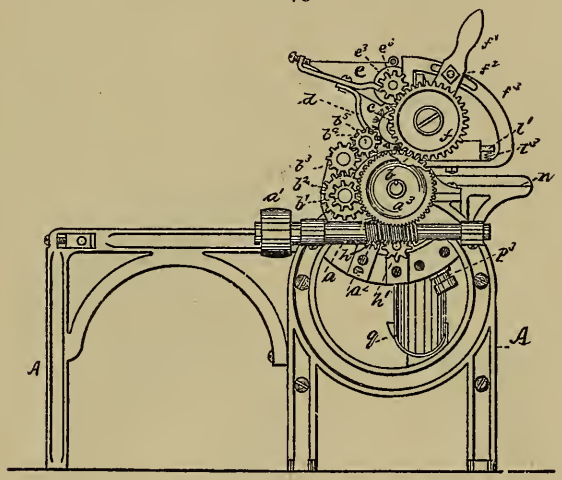
Brushes for blacking leather are made in both the oval and round form by the Vaughn Machine Co., Peabody, Mass.

BATCHELDER'S LEATHER BLACKING, COLORING AND DRESSING MACHINE.

Figs. 73 to 85 show the leather blacking, coloring and dressing machine patented by Batchelder, and built by the Vaughn Machine Co., Peabody, Mass.

Fig. 73 is a left-hand-side elevation of a machine embodying Batchelder's invention; Fig. 74, a front view thereof, with the table *n* omitted; Fig. 75, a longitudinal vertical section of Fig. 74; Fig. 76, an enlarged detail to be referred to; Fig. 77, a detail in top view of Fig. 76, with the brush *c* omitted, and Fig. 78 is a modification to which reference will be made.

FIG. 73.



This machine will also black grain leathers and season oil skins.

The blacking or liquid dressing, or material to be applied to the upper surface of the hide or skin, *B*, is placed in the receptacle *e*, which is shown as an open box, the sides of which, at its lower end; are concaved, to fit the periphery of the receptacle-roller e', which may be made to travel near the straight lower edge, 2, of the bottom of receptacle by means of the adjusting screws e^2, the amount of space between the edge of the bottom of the receptacle *e* and the roller e' determining the

FIG. 74.

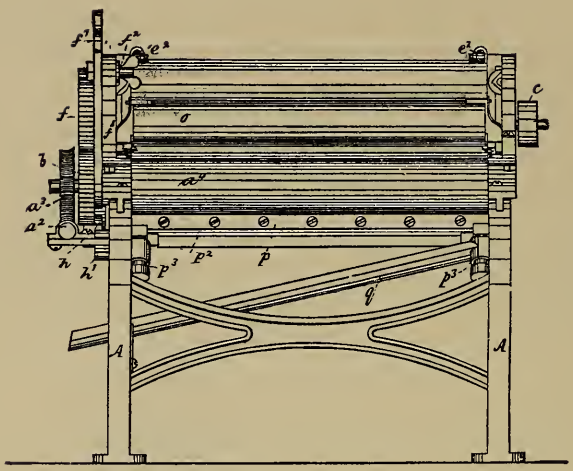


FIG. 75.

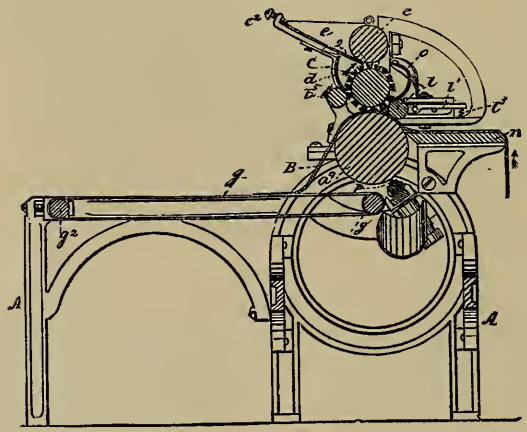


FIG. 76.

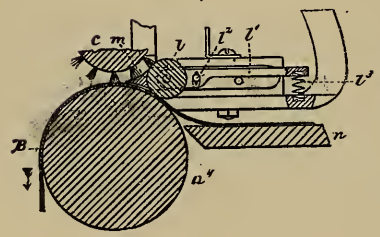
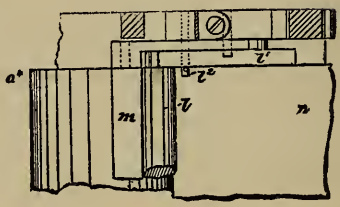
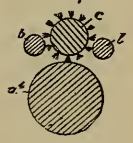


FIG. 77.



amount of blacking or dressing to be delivered to the brush *c*. The roller e' may be driven more or less rapidly to carry or deliver more or less blacking or dressing to the brush *c*. This may be done by changing the size of the gear e^3 on the journal of the roller e', the toothed speed-wheel *f*, which engages the gear e^3 and drives the roller e', being mounted on a stud of an adjustable carrier, f', provided with a locking device, f^2, to engage an arch, f^3, and hold the carrier in proper position.

Fig. 78.



It is preferable to slightly groove, flute, or pit the roller e', to enable it to take up a greater quantity of blacking or dressing. The hide or skin as it leaves the supporting-surface a^4 is delivered upon an endless belt or moving bed, *g*, shown as composed of cords or tapes extended about rollers g' g^2, the one g' being driven positively from the toothed wheel *b* by the intermediate worm, *h*, which engages the pinion h' at the end of the shaft g'. The tanned hide or skin to be dressed is introduced between the supporting-surface a^4 and roller or brush *c* under a roller, *l*, which, as clearly shown in Figs. 75 and 76, has its journals mounted on levers or arms l', pivoted at l^2 and acted upon by springs l^3, to keep the roller depressed upon the hide or skin to properly hold it. The front ends of the levers or arms l' are joined to a holding-bar, *m*, which is of a shape to fit the space between the brush *c*, the support a^4, and roller *l*. The under side of this holding-bar (see Fig. 76) is so shaped, curved, and located with relation to the surfaces of the roller *l* and the supporting-surface a^4 as not to bear upon the hide or skin until after the passage of the edges of the same beyond the nip of the roller *l*, the holding bar being devised to act upon and hold the end of the hide or skin, after passing beyond the nip of roller *l* (the latter then dropping), and prevent the hide or skin being drawn in too rapidly. In front of the apparatus there is placed a table, *n*.

In some instances and for some classes of work the inventor modifies the machine so far described, as represented in Fig. 78, and where there is shown the roller *l* as elevated consider-

ably above the position shown for it in Figs. 75 and 76, and in such position there will be left sufficient space to permit the operator to retain hold of and control the position and movement of the hide or skin being acted upon by the brush or roller *c*, and in such case also the holding-bar *m* is omitted.

To prevent the blacking or dressing being thrown from the brush or roller *c* toward the front of the machine there is provided the auxiliary spatter-guard *o*. The roller *l* and the holder *m*, when used, also serve to prevent the blacking or liquid dressing from being thrown out at the front of the machine. The supporting-surface a^4 and brush *e* are as long as the maximum width of the hide or skin to be blacked or dressed; but as the hides or skins being finished or dressed are always different, both as to width and outline at their edges, it results that the brush *c* always applies blacking or dressing to more or less of the surface a^4.

The blacking or dressing applied to the surface a^4 must all be removed and the surface left clean so as not to apply blacking or dressing to the under side of the hide or skin as it comes in contact with it. To do this the inventor has provided a wiper or cleaner, *p* (shown clearly in Figs. 74 and 75), as a strip of flexible material held by a suitable adjustable bar, p^2, so that the edge of the wiper or cleaner may be pressed with more or less force against the surface a^4, the degree of its pressure being preferably regulated by adjusting-screws p^3. The material wiped or scraped from the surface a^4 drops into the trough *q* and passes therefrom into a suitable pail or bucket to be rinsed, if desired.

By driving the brush-roller *c* and the supporting surface a^4 independently, the inventor is enabled to rotate either at any desired speed, and thus rub the blacking, coloring, or dressing matter more or less into the surface of the hide or skin.

The bearings for the brush *c* and roller e' will preferably be made adjustable vertically to accommodate for the thickness of the leather and compensate for wear.

Batchelder in 1883 patented an improvement on the machine

just described, which improvement is shown in Figs. 79 to 82. In the machine described in Figs. 73 to 78, the brush-roller which applied the blacking or the liquid dressing to the leather on a rotating supporting surface or roll had its bristles set radial; but with such a brush the distribution of the blacking is not so uniform and thorough as is desirable; so to cause the brush to apply the blacking to every minute part of the face of the leather being blacked or treated, Batchelder has inclined the bristles of the alternate rows of bristles of the brush in dif-

FIG. 79.

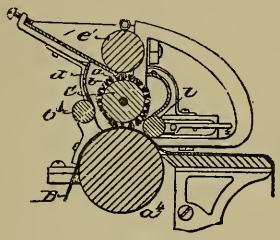


FIG. 80.

FIG. 81.

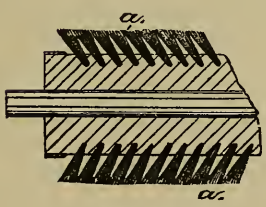
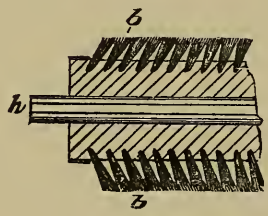


FIG. 82.



ferent directions, those of one row inclining toward one end of the cylinder and those of the next alternate row toward the opposite end of the cylinder, so that the ends of the bristles, besides traveling over the leather in the direction of rotation of the brush-roller, also, when in contact with the leather, spring or yield in opposite directions, the free ends of the bristles of alternate rows moving in opposite directions longitudinally as compared with the axis of the brush-roll, thus working the blacking backward and forward across the leather, as well as in the direction of its movement over the supporting-surface. In

this way every particle of the upper side of the leather is effectually blacked and streaks are effectually prevented.

Fig. 79 represents in section a sufficient portion of a leather blacking or dressing machine to illustrate the present improvement; Fig. 80, an end view of the brush-roller on a larger scale; and Figs. 81 and 82, two partial sections thereof in the dotted lines x and y.

The supporting bed a^4, color-roller e', deflector d, spatter-roller b' and roller i are as in the machine shown in Figs. 73 to 78. The roller c, which applies blacking to the leather B, has its alternate longitudinal rows of bristles a b inclined in opposite directions, those of one row being as in Fig. 81, and those of the next row as in Fig. 82, so that as the bristles yield on coming in contact with the leather B those of one row, as in Fig. 81, will yield and move toward the left end of the brush-cylinder, while those of the adjacent row (see Fig. 82), oppositely inclined, will move toward the right of the cylinder, the bristles of the two rows thus moving over the leather one after the other in opposite directions, in the direction of the length of the supporting roller a^4, at the same time that all the bristles sweep over the leather as it is carried under it by the roller a^4. In this way the blacking is brushsd on the leather both longitudinally and transversely. The brush-cylinder has a metal journal at each end, the journal preferably forming part of a metal shaft extended through the cylinder c of wood. The cylinder c is provided with a series of diagonal holes at opposite inclinations (see Figs. 81 and 82), into which the bristles a b are inserted and held by glue and wooden plugs or galvanized nails, or in any usual manner.

CHAPTER XIX.

MACHINES FOR ROLLING, PEBBLING, GLASSING OR POLISHING, FINISHING, ETC.

THE leather after being properly blacked is next submitted to one of the finishing processes, and while this operation is sometimes performed by hand, still by far the greater part of the leather curried in this country is glassed by machinery, and a large number of contrivances have been invented for this purpose, as well as for pebbling, finishing and similar operations. The scarcity of labor in all the Northern States from the commencement of the late war of the rebellion, and the enormous demand for leather which immediately arose, stimulated inventors in all lines of leather production, and machinery for this purpose which came into use from 1860 to 1873 is still the kind that is now commonly employed with many improvements in all sections of the country.

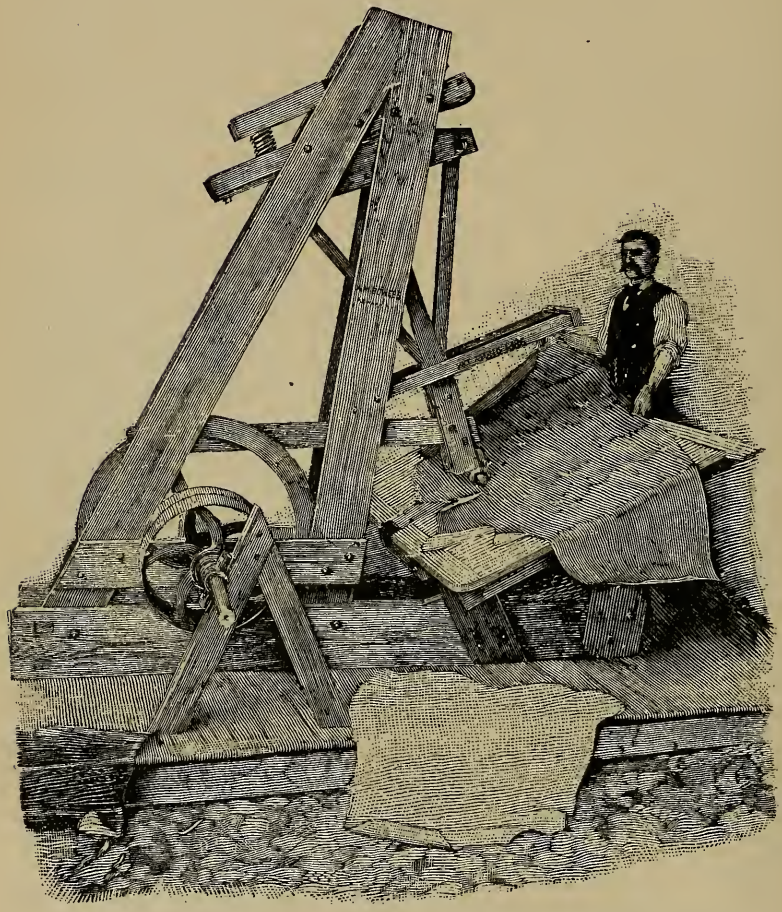
The glazing machine was one of the first steam-driven tools introduced into the trade. It was, at first, thought it would do away with hand-glazing entirely, but subsequent developments proved that it could only be utilized upon the heavier grades of stock.

The present machine, however, is a vastly improved and much more delicate piece of mechanism, to which the finest grades of stock can be entrusted without fear of its being burnt or torn into fragments.

In Fig. 83 is shown an illustration of the Bowers Rocker-Motion Leather Finishing Machine, made by Albert M. Bowers, Newark, N. J.

This machine is now largely used for glazing, rolling, pebbling, stoning, brushing and finishing leather, and it is an im-

FIG. 83.



BOWERS ROCKER-MOTION LEATHER FINISHING MACHINE.

provement over other modes of finishing leather in the method of construction over other machines.

The rocker motion insures economy of power, the rocker being the segment of the circle, while other machines are made with a slide or pendulum, or with a link motion, and the adaptation of the rocker as a resisting power removes all friction possible. At the same time it insures the machine to run

without heating and without flinging oil upon the leather while it is in operation, two very important factors, as a spot of oil upon fancy leather would spoil the whole skin.

Mr. Bowers also gets great power for rolling and pebbling. In the construction of the machine, the larger part is wood. The wooden part, being the resisting part, is in direct sympathy with the leather, and while the machine could be built of iron, yet machines built of iron, Mr. Bowers claims, are too rigid in practice to work upon leather, having been demonstrated many times upon the same kinds of leather. Therefore this machine takes the lead of other machines for like purposes, and is a studied improvement over first machines manufactured.

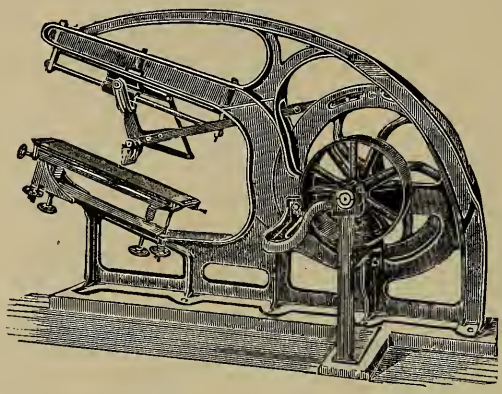
With it, it is also possible to stone out hides preparatory for the splitting machine. All kinds of leather, the whole hide or the sides, sheep skins, goat skins, skivers, bag leather, and all kinds of leather that are made to imitate natural grains, can be pebbled with it. In glazing, it will glaze every kind of leather to the greatest success. It will glaze the whole hide, the sides, sheep skins, skivers, goat skins; is used for glassing, shoe grain, polish leather, bag leather, harness leather, brush backs, hat sweats, on cloth and paper imitations of leather, on the thinnest buffings. Will glaze the different shades of colored leather to perfection, being free from danger to fling oil upon colored leather. It is used for glassing out suspender leather, insole splitts, buffings, heavy belt leather, and in fact it is used on every kind of leather that is required to be glazed.

Used also for rolling shoulders and trimmings, calf-skins for pocketbook stock in all its branches, for glazing alligator, lizard and snake skins, and has been subjected to the severest trials, and most arbitrary requirements. Over 1775 of these machines are in operation to-day.

It is also being extensively used in pocket-book factories to glaze the small pieces of stock after having been cut into the different sizes and shapes for pocket books, after the edges have been shaved to restore the gloss to the pieces from finger-marks and other handling.

The improved iron glassing jack, made by J. T. Freeman & Co., Woburn, Mass., is shown in Fig. 84.

FIG. 84.



IMPROVED IRON GLASSING JACK.

This is a self-contained machine, all of iron and steel but the table. It has no posts or braces, and the peculiar construction of the frame insures great rigidity and consequent effectiveness. It is so constructed that the pressure can be regulated by a small hand-wheel in front of the bed. There is also a bolster stretcher attached to lower end of the bed, to draw up the stretch of the bolster. The machine requires no special setting up, as it is shipped altogether on a wooden base; all that is necessary is to level up same and bolt firmly to the floor. The manufacturers guarantee this machine to work equally as well on the paste or black; also on buff, harness or belt leather.

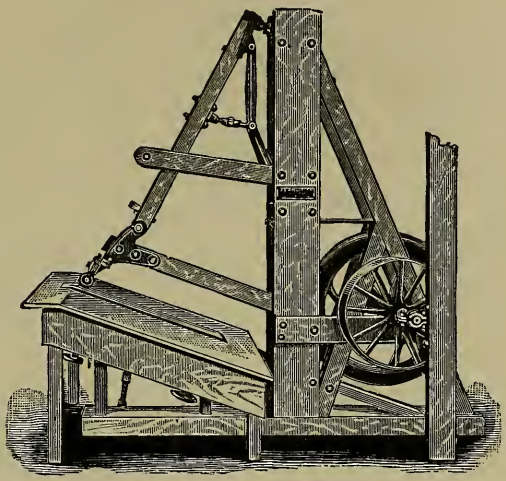
Fig. 85 shows the improved straight bed rolling or pebbling jack made by J. T. Freeman & Co., Woburn, Mass.

Owing to the increased demand for a straight bed pendulum machine, and being desirous of having a jack of a different construction from any other manufacturer, the builders designed the above machine. The bed of this jack is perfectly straight; the arrangement under the bed is the same as a pair of scales, thus giving an equal pressure on all parts of the stroke, and has

only one small spring in the center. It is a very heavy machine and works equally as well on light or heavy stock. The builders have given this machine a thorough trial and feel safe to say that it is second to none on the market.

The anti-friction roll made by J. T. Freeman & Co., Woburn, Mass., is especially adapted for heavy work, also on colored leather and skins. It requires no oil, and thus overcomes all

FIG. 85.



IMPROVED STRAIGHT BED ROLLING OR PEBBLING JACK.

grease-spots on the leather. The makers will guarantee it not to heat or burn the leather, but to warm up just enough to give a good bright polish on the stock. Rolls can be furnished to fit almost any rolling or pebbling jack.

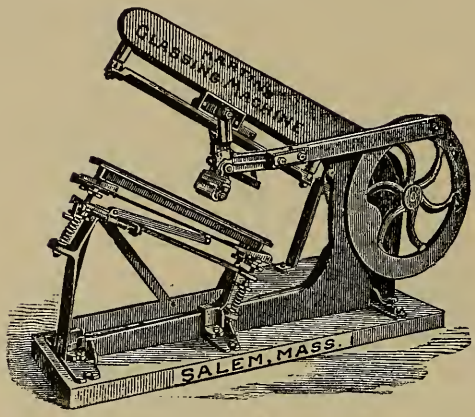
MARTIN'S IMPROVED MACHINE.

Martin's improved machine is shown in Fig. 86.

It is built by William F. Martin, Salem, Mass.

For simplicity of design, compactness, easy and silent action, facility of adjustment, quantity and quality of the work it will perform, and the high rate of speed at which it can be operated, it needs only to be examined to commend itself to every one

FIG. 86.



MARTIN'S IMPROVED MACHINE.

using machinery in all the branches of the leather-finishing industry.

In currying it will "set out" pebble, "stone out," "glass in black and paste," using either oil or soap blacking, entirely without hand labor.

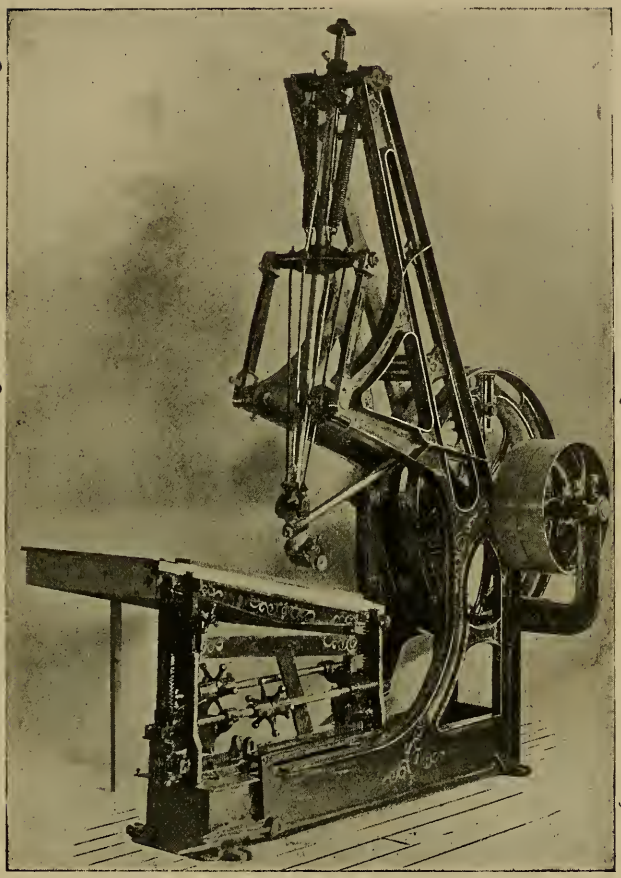
For the morocco or lining finisher it will glaze, roll, pebble and glass out, doing a quality of work equal to any machine now in use.

THE KNOX IMPROVED INCLINED BED LEATHER FINISHING AND PEBBLING MACHINE.

In Fig. 87 is shown an illustration of the Knox improved inclined bed leather finishing and pebbling machine, built by the David Knox & Sons Machinery Company, Lynn, Mass. This machine can be used for finishing and pebbling all kinds of leather.

A medal and diploma were awarded these machines at the Centennial Exhibition for "excellence of work done, simplicity and durability of all parts, and for the little power needed to operate them, and ease in adjusting and running them, they stand beyond all question unrivaled." The frames have been re-designed, adding greatly to their strength and

FIG. 87.



THE KNOX IMPROVED INCLINED BED LEATHER FINISHING AND PEBBLING MACHINE.

rigidity. All these machines are now furnished with the new slotted balance-wheel, having an adjustable stroke from 16 to 32 inches, and making a very easy and smooth-running motion. The outside bearings recently put on give great steadiness and smoothness to the motion of these machines.

Patents have been granted for improved adjustments for the bed. Besides giving a range of nearly three inches for raising

the bed, the adjustment for regulating the tension of the springs is absolutely separate from and independent of that raising the bed. This allows the most perfect and delicate adjustments to be accomplished with ease and facility.

These machines are used in polishing, glazing, dicing and pebbling all grades of leather with the same remarkable success, from the lightest French kid to the heaviest currier's work. The best evidence of the value of these machines is shown by the increased sales during the past five years, and the large number used by the leading firms in this country, many running constantly from five to fifteen machines.

An extra wide bed, carrying a strap six inches wide, is especially adapted for currier's work.

The Company also makes an improved level bed bottom finishing and pebbling machine. They claim for these machines:

First: Great strength and rigidity of frame—qualities in which they excel all other machines made.

Second: That these machines are complete in themselves—not havfng any of their working parts attached to or depending on the building, and well-balanced in all their movements, so that in running at any speed, they will not rack or injure the building.

Third: A range and ease in adjustment possessed by no other machine.

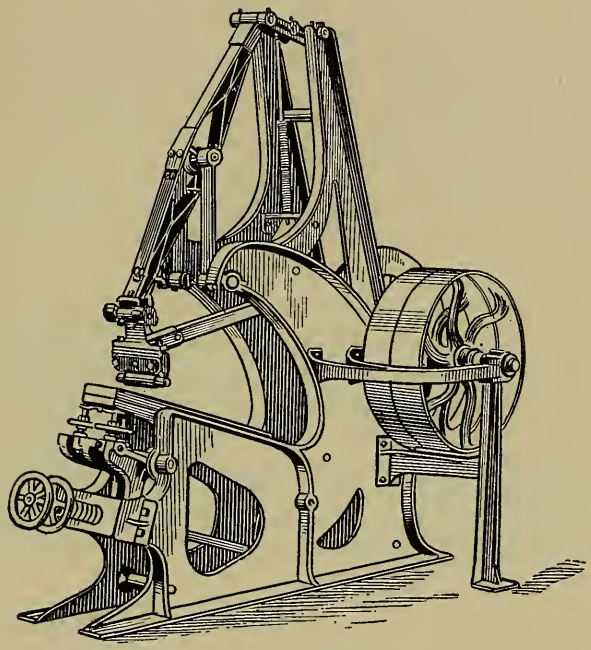
Fourth: That the adjustmcnts for the bed are simplicity itself, and are independent of each other. They are all within easy reach of the operator, who has the machine under complete control without changing his position for glazing. The whole bed can be instantly dropped one-half inch, clear of the tool, and as quickly raised into position for work. This allows the machine to be run all the time without any useless wear on the strap, a very important feature, for which the Company has patents pending.

Fifth: That there is absolutely no wear-out to any of the working parts of the bed, and no possibility of its getting out of order by the work.

Plain and figured agates, glasses and flints, leather, wood and fibre straps, smooth and pebbling rolls of all kinds furnished to order.

Fig. 88 shows the celebrated Coombs Pendulum Jack made by the Vaughn Machine Company, Peabody, Mass.

FIG. 88.



COOMBS PENDULUM JACK.

What the manufacturers claim for it is:

First: That it is all iron and steel except the face of the bed. It is all contained in one frame, and consequently cannot get out of line, there being no wood to shrink and become loose.

Second: That we use a straight bed, which gives the operator better control of the leather and does not wear out the bolster, as the curved bed does.

Third: That our jack will run 25 per cent. easier than any other jack doing the same work.

Fourth: That it is heavier, stronger and more durable, being made of the best material and in the most workman-like manner.

Fifth: That the arrangement of the bed is entirely new, and is the best that has been produced by any one so far. The reason is this, that you can get an absolute even pressure all over the bed and more elasticity than on any other machine. You can also have perfect control of the bed from the front of the machine, one screw raising or lowering both ends of the bed at the same time, and one screw regulates the pressure for both ends of the bed. There are also two other screws to adjust the bed to any desired position.

Sixth: That our jack can be run with less repairs, as all the bearings are babbitted, and the boxes have caps to take up the lost motion.

Seventh: That our machine occupies the least possible space, the height 7 feet 10 inches, the floor space 6 feet by 7 feet.

This machine is designed especially for printing, or any heavy work. The manufacturers build this machine lighter to do glassing and polishing.

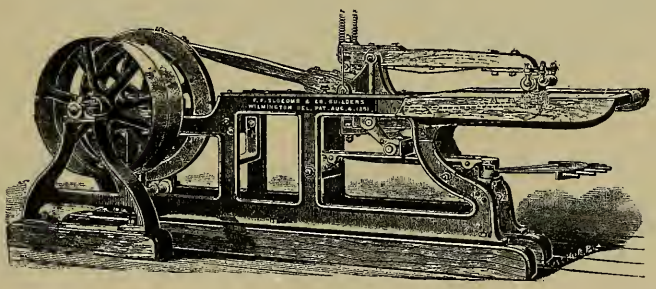
They also make and cut pebbling rolls of any pattern desired.

CHAPTER XX.

STAKING MACHINES.

THE "hand-method" staking machines (shown in Fig. 89), built by F. F. Slocomb & Co., Wilmington, Del., is now fitted where required with a swivel pressure adjustment of novel design, which is claimed to be far more practical and exact than any prior device for the purpose. Other recent improvements enable this machine to stake successfully many classes of work

FIG. 89.



"HAND-METHOD" STAKING MACHINE.

heretofore either impossible to do on any machine or else indifferently done. Among these may be mentioned several varieties of fine glove leather, fine kid, alum, sheep and lambs, etc., and chrome tanned skins generally. On kangaroo and kangaroo calf, etc., and Russia calf, the firm state that their improved combination padding and staking jaws of leather and felt will surprise users by the fine quality of work done. In addition they have two other sets of staking jaws, all different and giving different results, thus fitting one machine to do many lines of work by merely changing the jaws. The advantage of this has been shown many times over in factories

where any change in tanning or finish has occurred. Machines are built in four sizes, suitable for any work, from lamb skins to whole hides.

This machine takes the place of knee or arm staking and padding on light work, and soft boarding on heavy work.

The staking machine is a marked improvement over the hand stake. This latter was not used in the morocco branch of the trade until the dawn of the present era of chrome tannage. It was an upright wooden stake, some two feet in length and eight inches in width, into the tapering top of which was fixed a broad steel blade. The skin was drawn across this blade, the weight of the workman's body being thrown upon it. Great care was exercised in order to guard against cutting the skin; should this occur, the staker's balance would be lost, and he would be in danger of being impaled upon his stake.

The staking machine accomplishes the work of a half dozen hand stakers. There are several makes in use, and improvements are constantly being added.

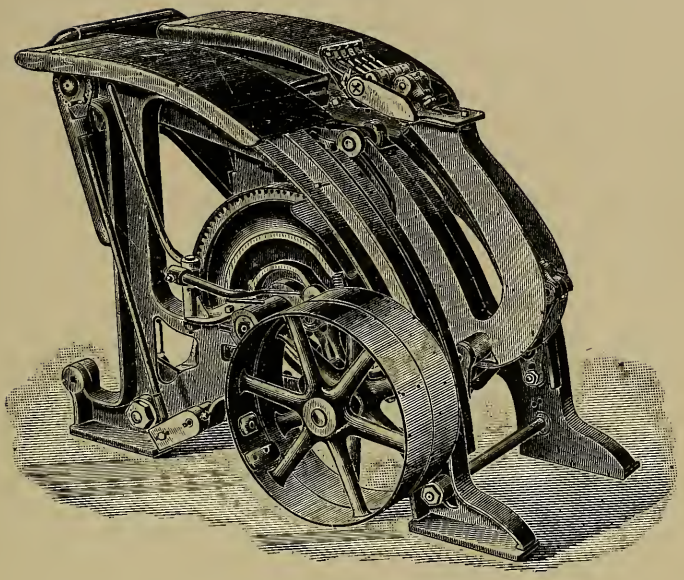
The staking machine shown in Fig. 90 is built under the Stakpole patent by the Vaughn Machine Co., Peabody, Mass., and it successfully meets all the requirements of the morocco and light leather trade. The leather is staked with the grain side up, so the operator sees just what is being done through the whole operation.

The tension is instantly applied or released by hand or foot, and the jaw with its flexible fibre pad cannot be equaled by any other device for this work.

It will take out the stretch in the leather thoroughly, softens perfectly and no damage or tearing. No danger of grease spots or soiling in the least any fancy colored stock.

Floor space required, only 4½ ft. x 3 ft. Simplicity of construction and operation. Self-contained and no jar or noise perceptible when it is in operation. Minimum of power required, a two-inch belt will run it. Maximum amount of work obtained.

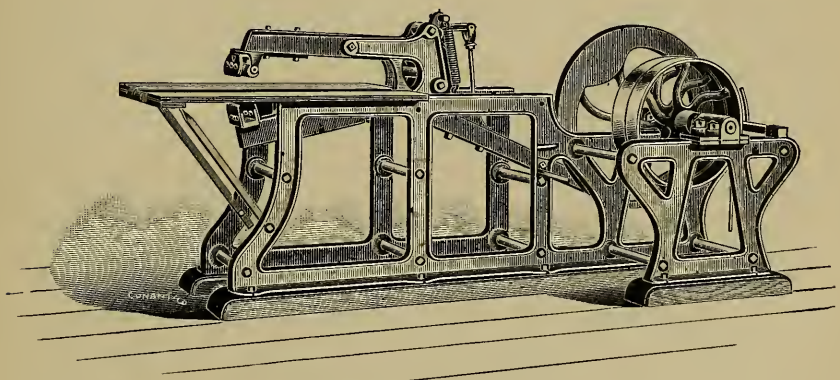
FIG. 90.



STAKPOLE STAKING MACHINE.

Fig. 91 shows the staking machine built by Wm. F. Martin, Salem, Mass. It can be adjusted to any kind of leather, including napa. For napa an extra tool is required for spread-

FIG. 91.



MARTIN'S STAKING MACHINE.

ing out the leather, and it is furnished by the manufacturer when required. This machine is unexcelled on calf, kangaroo, chrome, Russia calf and glove leathers. It is noiseless in action and is run by a smaller amount of power than any other staker on the market. Pressure can be adjusted while the machine is in operation.

Staking machines are also built by Geo. W. Baker & Co., Wilmington, Del., and others.

CHAPTER XXI.

MACHINES FOR MEASURING LEATHER.

THE heavy leathers are sold by weight; but light leathers, such as upper, morocco, sheep-skin, and enamel leather, are sold by area in the United States. The yardstick, and the common measuring frame, having wires or cords running the length and across it, thus dividing the frame into square feet, do not require special description.

Tanners of sole leather by a quick process are talking of selling sole by measure instead of weight. They claim that the buyer gets nothing but leather when made by this process. An idea being broached by shoe manufacturers is to have the fraction of a foot reduced to eighths instead of quarters, as is done on the measuring machines. Nearly all large manufacturers remeasure their leather, and discrepancies are often found between theirs and the original measurement.

SAWYER'S LEATHER MEASURING MACHINE.

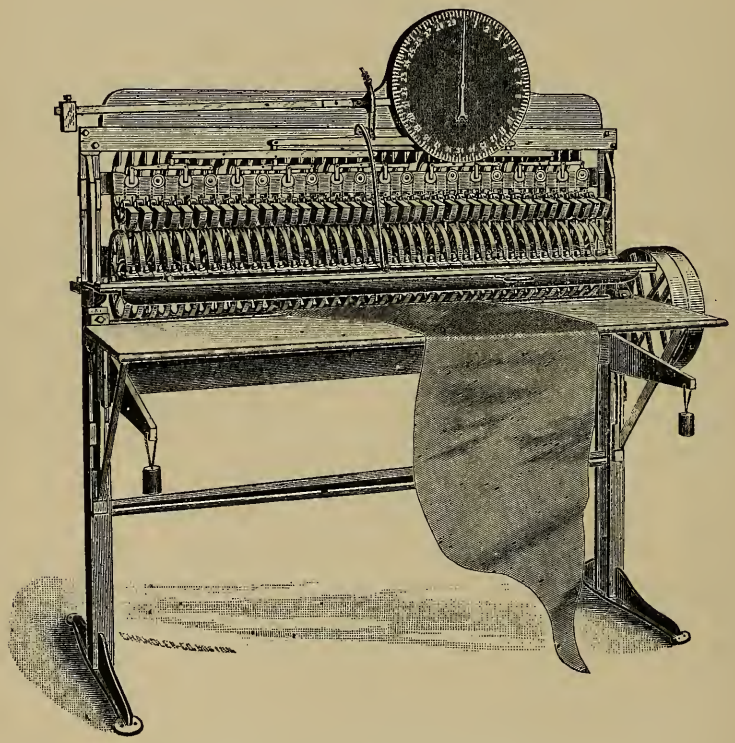
The Sawyer self-adjusting leather-measuring machine is shown in Fig. 92. It is sold by the Sawyer Leather Machinery Co., Boston, Mass. It is constructed on a different principle from other machines for measuring the areas of surfaces, and it can be operated by either hand or power.

A minimum of power will run this machine, and it can be operated at a fast or slow rate of speed; 65 revolutions per minute is a good average, which gives five sides in that time. Wax, grain, enamel, goat and sheep-skins are perfectly measured by this machine, which is made in three different sizes (5, 6 and 10 feet), to suit the various leathers. The machine is made of metal, and any of the series of wheels may be removed or replaced without interfering with the others.

Sawyer's invention consists in an arrangement of levers by which the travel of each measuring-wheel is caused to properly affect the index of the registering device.

The article to be measured is fed into the machine between the wheels and roller, and the leather is smoothed out as it passes between them, and so records every inch in the surface.

FIG. 92.



SAWYER'S LEATHER-MEASURING MACHINE.

Fig. 92 illustrates a perspective view of the front of the Sawyer machine.

For the purpose of establishing a standard of measurement of leather, the trade generally signed an agreement making the Sawyer measuring machine the standard. This is the first and

only formal endorsement by the trade of any invention whatsoever as the standard of measure for leather.

The Sawyer leather measuring machine was given the highest award, a gold medal, at the great exhibition of the Massachusetts Charitable Mechanics' Association in 1884. Again at the Exhibition of 1887, it was in competition with all of the machines known for the measuring of leather, and again it received an award of first class—a special diploma, affirming the award of the gold medal for its continued excellence, while no other measuring machine received an award above the fourth class. (For confirmation of this statement we refer to the records of the Mass. C. M. Association.) The reasons for this distinction are that the Sawyer is the only machine measuring accurately every description of leather in any condition whatsoever, wrinkled or smooth, and is consequently the only machine available to manufacturers of boots and shoes whose stock comes to them folded and creased. It stands, therefore, alone in its universal application, and is now practically regarded as the standard of measure for all upper leather in the United States, England and Germany.

THE UNION LEATHER MEASURING MACHINE.

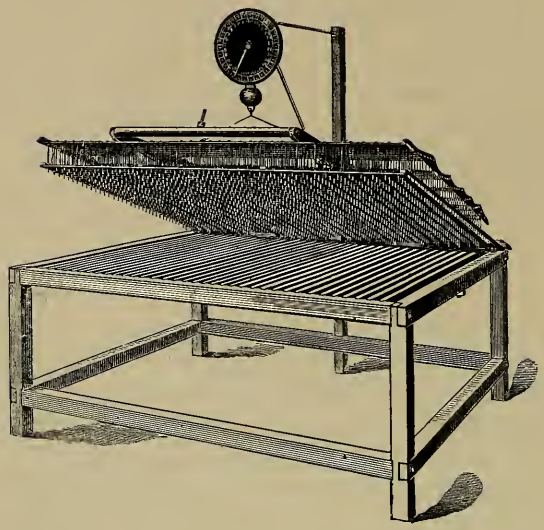
Fig. 93 illustrates the Union leather measuring machine, which is offered to all who deal in leather in any form and now in constant and most satisfactory use by well-known dealers.

Experience has demonstrated that this machine has no equal for accuracy, rapidity, ease, and simplicity of action, and for low cost both of running and of original purchase.

The machine is made in three sizes: No. 1, 5 x 4; No. 2, 6 x 4½; No. 3, 10 x 4½ feet. The Union Leather Measuring Machine Co., Danversport, Mass., who manufacture the machine, are willing at any time to meet all competitors in a trial for accurate measurement. Wm. O. Hood, Danversport, Mass., is the agent for the sale of the machine.

This machine is a simple mechanical arrangement for rapidly measuring, within a very small limit of error, the superficial

FIG. 93.



area of any plain surface having a close texture, regardless of its irregularity of outline. This difficult problem is accomplished by means of a flat grid or table of suitable height and properly framed, the area of top being formed of wooden strips about seven-eighths of an inch thick and set at right angles to the front, with interstices of 1⅛ inches. Upon the table the object to be measured is placed. Above the table, and corresponding thereto in its area, is a double frame hung upon anti-friction pivots at the back, so as to open like a trunk cover, or close down to a suitably fixed distance from the table. Throughout the entire surface of this upper frame are suspended, at intervals of 1½ inches by 2 inches, small wires (free to slide up through holes) of such sizes and lengths that each will exercise the same influence as to weight as any other, that is to say, the nearer the fulcrum the heavier the wire. The weight of forty-eight of these wires corresponds to one square foot of area, and thus the upper frame containing them being brought down to the table, the object thereon throws up all the wires which come in contact with it, and the ends of the remaining wires drop be-

tween the slats of the table. The released weight of the wires which have been thrown up is indicated by a spring balance down to one-eighth of a square foot. However irregular the the outline, the area will be embraced by the pins down to a section of 1 ½ by 2 inches, the error of one pin being but the forty-eighth of a square foot; it thus approaches absolute accuracy very closely

THE BOLTON MACHINE.

J. P. Bolton, Boston, Mass., has invented a planimeter for showing the area of leather. The leather is drawn over the table between a roll and a series of integrating wheels, mounted in pivoted and adjustable frames. Back motion is prevented by pawls, which can be simultaneously thrown out of action by an eccentric operated by a crank and handle bar when it is desired to zeroize the apparatus. The wheels have coiled in their hubs cords leading to weights in a series of tubes partially filled with liquid and connected to a tank. A tube is also connected to the tank and provided with a float carrying a graduated scale. Whenever any wheel is rotated by a portion of the skin passing beneath it, the corresponding weight is drawn upwards. The movement of all the weights is instigated by the movement of the water level in the tube, and the area is read off from the scale.

CHAPTER XXII.

MINERAL TANNING SUBSTANCES—"CHROME," OR MINERAL TANNAGE—CHARACTERISTICS OF CHROME-TANNED LEATHER—CURRYING—DYEING.

THE use of mineral tanning materials dates back to very remote times, since history teaches us that the Saracens used alum and aluminium salts for tanning skins. These substances were in fact for a long time the only tanning materials employed for preparing leather, a series of other mineral substances for tanning having been only recently introduced as a substitute for vegetable substances.

The principal mineral substances we have to consider are:

1. Alum, aluminium sulphate and aluminium acetate.
2. Chromates and chromic oxides.
3. Hyposulphite of soda.
4. Ferric salts.
5. Common salt.

ALUMINIUM SULPHATE.

Neutral aluminium sulphate ($Al_2 3SO_4$) is prepared either by treating clay or bauxite with concentrated sulphuric acid, or from cryolite. In an anhydrous state it contains 30 per cent. of alumina and 70 per cent. of sulphuric acid. With eighteen equivalents of water it crystallizes into octahedrons or at a temperature of 32° F. into hexagonal rhombohedrons. Aluminium sulphate is soluble in double its weight of water. A solution prepared with the assistance of heat separates, on cooling, crystalline lamina or aluminium sulphate ($Al_2 3SO_4 + 18H_2O$). It is found in commerce in a nearly pure state, the best qualities containing only traces of iron, but from 0.5 to 2 per cent. of free sulphuric acid, which is frequently injurious

when the salt is to be used for tanning purposes. The presence of free sulphuric acid may be detected by adding to a solution of aluminium sulphate some logwood tincture. The solution, if free acid is present, will be colored brown-yellow; deep violet, if it is neutral. To make aluminium sulphate containing free sulphuric acid available for tanning purposes, add to a solution of it 1 to 2 per cent. of zinc chips, the solution of which will be attended by a violent development of hydrogen. By the free sulphuric acid combining with the zinc, zinc sulphate is formed. An excess of zinc is dissolved with formation of zinc sulphate and separation of basic sulphate of alumina. Instead of zinc chips 1 to 2 per cent. of sodium carbonate may be used.

Aluminium sulphate, known in commerce as concentrated alum, is used in tanning as a substitute for alum. The skin absorbs, according to Knapp, up to 27 per cent. of it, which is removed by washing with water.

Alum ($Al_2 3SO_4 + K_2SO_4 + 24H_2O$), is formed by the combination of aluminium sulphate with alkaline sulphates. It is readily prepared by mixing solutions of the two sulphates. In evaporating the fluid, the alum crystallizes ont. Potash-alum and ammonia-alum dissolve with difficulty, they requiring 18.4 parts of cold water and 7.5 parts of boiling water, while soda-alum dissolves readily. From a hot saturated solution, the alum separates in octahedrons, and from alkaline solutions in hexadrons. The last variety is called in commerce cubic alum, and, being nearly free from iron, is valued more highly than the former. Alum has at first a sweetish taste which changes into an astringent. By heating it loses gradually its water of crystallization, becomes anhydrous, and is converted into the so-called burned alum. Ferric sulphate, manganous sulphate, and chromium sulphate, which are isomorphous with aluminium, form also double salts when combined with potassium, sodium, or ammonium sulphate. The resulting combinations are called iron alum, chromium alum, and manganese alum. Instead of alumina they contain ferric oxide, chromic oxide or

manganic oxide. They crystallize in the same form, and contain an equal quantity of water of crystallization:—

Iron alum = $Fe_23SO_4 + K_2SO_4 + 24H_2O$.

Manganese alum = $Mn_23SO_4 + K_2SO_4 + 24H_2O$.

Chromium alum = $Cr_23SO_4 + K_2SO_4 + 24H_2O$.

If several of these alums in solution are present in one fluid, the crystals separating from it contain the different bases in varying quantity. It is due to this circumstance that alumina alum contains frequently iron alum, which it is often impossible to remove even by repeated recrystallization. In tawing and in mineral tanning potash-alum is principally used.

For a complete saturation the skin tissue absorbs, according to Knapp, 7 to 8 per cent. of alum.

The tanning properties of alum are principally due to the alumina salts it contains.

In absorption by the skin tissue, the alum, according to Knapp and Raimer, is split, the aluminium sulphate or basic aluminium sulphate precipitating upon the fibre, while the potassium sulphate remains in the liquid. In the presence of common salt in aqueous solution, the alum, according to Knapp, is not converted into aluminium chloride and sodium sulphate.

Iron and chromium alum act upon the skin tissue in the same manner as aluminium alum.

Aluminium acetate ($Al_26(OC_2H_3O)$) is prepared by dissolving alumina in acetic acid or compounding lead acetate with aluminium sulphate or alum. Heating during the process should be avoided. Experiments have lately been made in using aluminium acetate in place of aluminium sulphate or alum.

It does not separate, it is claimed, in a crystalline form in the skin, and the leather tanned with it does not become spotted, as is frequently the case in tanning with alum. The tanning with this salt is more solid than with alum, since the aluminium acetate decomposes more or less in the leather by the formation of basic salts or free alumina.

A further advantage claimed for aluminium acetate is the absence of free sulphuric acid, which is split off from the

aluminium sulphate and exerts a very injurious influence upon the leather.

CHROMIUM SALTS.

Experiments have been made to use chromates mixed with alumina salts for tanning in place of vegetable substances.

The most important for this method of tanning is *potassium bichromate*, from which all other chromic salts and compounds of chromium used for technical purposes are derived. The salt is chiefly manufactured in three large eslablishments in England, from whence it is sent to all parts of Europe and partly to America. It is made by roasting a mixture of finely powdered chrome iron-stone with potassium carbonate upon the hearth of a reverberatory furnace for several hours with constant stirring of the mass. The chromium oxide is oxidized to chromic acid, the latter combining with the potassium to potassium chromate. The ferric oxide contained in the chrome iron-stone is separated as such. After thorough oxidation the roasted mass is lixiviated with water, whereby potassium chromate, a small excess of potassium carbonate and a few impurities, such as potassium silicate, pass into solution. The liquid is allowed to clarify by standing, and, after decanting, is evaporated if necessary, and the neutral potassium chromate converted into potassium bichromate by adding the required quantity of sulphuric acid. The potassium bichromate forms large bright garnet-red triclinic crystals. It is soluble with difficulty in cold water.

20	parts	of	water	at	32°	F.	dissolve	1	part of salt.
11.8	"	"	"		50	"	"	1	" "
7.65	"	"	"		68	"	"	1	" "
1.18	"	"	"		140	"	"	1	" "

Potassium bichromate is very sensitive. With glue, gelatine, gum, etc., it forms combinations which, after exposure to light, are insoluble in water, its employment in photography for preparing pigment or carbon pictures depending upon this property. Advantage is taken of this fact in several patents for chrome tannage.

It precipitates itself upon the skin fibre, and partially penetrates it.

Taken internally it has a poisonous effect like most metallic combinations. Placed repeatedly upon excoriated or sore places it produces running ulcers, which are, however, soon healed by washing with lead vinegar. It colors the sound cuticle yellow without destroying it. In pulverizing potassium chromate care must be had not to allow the powder to enter the nostrils, as it produces violent itching and severe spells of sneezing.

Sodium bichromate is more soluble in cold water than potassium bichromate, but it crystallizes with difficulty. It is used in the two bath chrome processes; but potassium bichromate is more generally employed.

Calcium bichromate, strontium, and barium are soluble in water, while the neutral chromates of calcium, strontium, and barium are soluble with difficulty, the barium salt, which forms a well-known art color, being almost insoluble in water. Lead salts give with chromic salts insoluble precipitates, which are used as painter's colors.

The neutral chromates are yellow, readily soluble in water, and can be used in place of the bichromates, but being dearer than the latter offer no advantage.

Chromium alum is the most important of the chromium salts thus far introduced in tanning. It is prepared by mixing chromium sulphate with alkaline sulphates. It crystallizes from the fluid in octahedrons.

In speaking of alum, it has been mentioned that chromium alum acts upon the fibre in the same manner as aluminium alum, but the tanning of leather prepared with aluminium alum being, as we will see later on, more perishable on exposure to water than that of leather prepared with chromates, the latter are preferred.

Chromic sulphate ($Cr_2 3SO_4$) is obtained by reducing chromic acid to chromic oxide, and dissolving in sulphuric acid. It is soluble in water, giving to the latter an emerald-green color, and has the same tanning effect upon the skin fibre as aluminium sulphate.

HYPOSULPHITE OF SODA.

Hyposulphite of soda is one of the materials called for by the two bath chrome tannage processes. This article is prepared as a by-product in several of the large European chemical factories. Attempts have been made to make it in this country, but unsuccessfully heretofore, inasmuch as it has been attempted as a main product, whereas the foreign manufacturers enjoy the advantage of its being a by-product. Of late, however, there has been successfully produced an American product which is proving to be merchantable. The increasing demand for a purer and dryer hyposulphite of soda has induced a company to start a large plant for producing the same. A very fine quality of this salt has been made in this country for the past four or five years, in a limited way. The same chemist that had charge of the smaller plant will be in charge of the larger one, and it is claimed that they can now furnish it in any desired quantity and of guaranteed quality. The advantages of the American hyposulphite of soda are that it contains less moisture and tests higher than the imported. A careful analysis of several different lots of German and English show that the American contains from 8 to 10 per cent. more pure hyposulphite than the German, and from 11 to 15 per cent. more than the English make.

The muriatic acid and sulphuric acid employed in the two bath processes are so well known that no especial description is necessary here.

FERRIC SALTS.

Tanning with ferric salts was already recommended in the last century by D'Arcet. Bordier, in 1842, obtained a patent for tanning by means of ferric sulphate produced by oxidizing ferrous sulphate.

In modern times Knapp has attempted to reintroduce in practice the method of tanning with ferric salts. The ferric sulphate used by him is also prepared by oxidizing ferrous sulphate with nitric acid, the latter being added to a solution of

the former until effervescence ceases, and all the ferrous oxide is converted into ferric oxide. After the cessation of the first effervescence ferrous sulphate is again added until effervescence ceases, the object of this addition being to reduce any excess of nitric acid used. The resulting basic ferric sulphate solution should be of a syrupy consistency, and contain chiefly basic ferric sulphate and a small excess of ferrous sulphate.

Prof. Knapp says that only basic ferric sulphate prepared in the above manner is adapted for tanning, on account of its amorphous condition and beautiful brown-yellow color and the indecomposableness of its aqueous solution in boiling, The commercial basic ferric sulphate, according to Knapp, does not give a syrupy solution, is of a much darker color, and the aqueous solution is decomposed by boiling.

This ferric salt is, according to Knapp, abundantly absorbed by the skin tissue and effects a complete tanning of the skin fibre. It is claimed that the salt absorbed by the skin cannot be removed by treating with water.

By precipitating a soap solution with the above basic ferric sulphate, Prof. Knapp prepares an *iron soap*, which is a combination of ferric oxide with sebacic acids. This, to complete the tanning process, is mechanically fulled into the skin, either by itself or mixed with fat solutions or emulsions.

COMMON SALT

occupies an important place in tanning. It serves, as has been previously mentioned, on the one hand for preserving skins, and on the other to accelerate the tanning process in tawing and mineral tanning. As regards its occurrence, preparation, etc., nothing need be said.

The salt found in commerce is either rock salt or that obtained from salt springs or sea-water, the latter being known as common salt. Both varieties contain varying quantities of admixtures, the principal being the sulphates of magnesia, lime, or gypsum, and the chlorides of calcium and magnesium. Common salt prepared from sea-water contains the most im-

purities, the principal being magnesium chloride, magnesium sulphate, calcium chloride, etc. The salt obtained from rock salt by recrystallization being the purest, is especially adapted for use in tanning.

In using common salt in tawing and mineral tanning, admixtures of magnesium chloride and calcium chloride are especially injurious, as they absorb water from the air, *i. e.*, they are hygroscopic.

When salt containing these admixtures is used for tanning, the leather produced with it absorbs water from the air and becomes moist.

"CHROME" OR MINERAL TANNAGE.

Investigators in the field of chemistry and experimenters in the art of leather manufacture have sought for a long time for some mineral substance that could take the place of tannin in converting hides and skins into leather. It may be said that Cavalin, Knapp, Pfanhauser and Heinzerling were among those whose valuable investigations opened the way for future success.

The first use of *bichromates* for tanning was made by Cavalin. The skins, according to his method, are placed in a solution of 22 pounds of potassium bichromate and 44 pounds of alum in 396 pounds of water, where they remain for four or five days with frequent stirring, when they are placed in a solution of 2.2 pounds of ferrous sulphate in 22 pounds of water. In this they remain for twelve hours, being in the meanwhile frequently stirred. The potassium bichromate is reduced to chromic oxide by the ferrous sulphate, and the ferrous oxide contained in the ferrous sulphate oxidized to ferric oxide, both oxides being precipitated as such upon the fibre, or the ferric oxide together with alumina. The fixing of the chromium combination is effected by reducing the soluble chromate to chromic oxide. Cavalin's method may be considered as a combination of tanning with ferric aluminium and chromic oxides. But a practical application of the process is not possible, since the leather loses its tannin easily when immersed in water, and its grain is brittle.

Knapp, in 1861, obtained a patent in Germany for tanning with ferric salts and other metallic oxides. Hides tanned with mineral substances lost, like those tanned with alum, their tannin by immersion in water. Knapp tried to remove this evil by converting the metallic salts adhering externally to the skin into insoluble metallic soaps, by soaking and kneading the skin in a soap solution. In order to fix the tanning substance in the skin, Knapp recommended, instead of *immersing* the tanned skins in soap solution, the *fulling in* of insoluble soaps of ferric oxide, aluminium oxide, or chromium oxide. The solution of basic ferric sulphate Knapp used for tanning was prepared by compounding the solution with caustic soda until the resulting precipitate was again dissolved in the fluid.

Next to Knapp, Pfanhauser obtained in 1864 a patent for the preparation of a basic ferric sulphate and its use for tanning. By his process ferric sulphate is heated to a red heat with constant stirring until the mass is converted into a reddish powder. The latter while hot is thrown into water, in which, with constant stirring, it is almost entirely dissolved. The resulting fluid is allowed to clarify by standing, and the clear liquor used for preparing tanning fluid of varying strength. The skins are first placed in a dilute solution of 0.5° Beaumé, and then successively in stronger solution. When thoroughly permeated they are washed off and placed in a soap solution.

Knapp, in 1877, gave a fresh impetus to mineral tanning by patenting in Germany and other countries a new method of tanning with ferric salts, a short description of which process is here given:

In the use of the basic sulphate of iron as a tanning material, the hides or skins, having the hair and adherent fleshy portions removed in the usual manner, are placed in the cold solution of the ferric oxide salt of the proper density, in which they are allowed to remain for two, or, at most, four days, during which time it is not necessary to handle the hides in any manner, all the laborious operations attending the use of tan-bark liquor, while the hides or skins are subjected to the action of such

liquor, being obviated. At the end of the time named the hides or skins are removed from the solution of ferric-oxide salt. This salt is prepared as follows: To a boiling solution of sulphate of protoxide of iron (green vitriol) is added as much nitric acid as will thoroughly oxidize the salt contained in said solution. When the effervesence which ensues upon the addition of the nitric acid has subsided, the operation is reversed—that is, sulphate of protoxide of iron is added to the solution till said solution assumes a syrupy consistence—a distinguishing characteristic aforementioned—and acquires a yellow-red color, also characteristic of solutions of this iron oxysalt, which, when slowly evaporated to dryness, has the appearance of an orange-red transparent varnish, also highly characteristic.

In this condition, it is claimed, the ferric sulphate possesses qualities differing essentially from those attributed to it in chemical text-books, or found in the commercial article. The latter gives no syrupy solution, is of a yellow-brown color, and in aqueous solution is decomposed by boiling, while the preparation produced according to the above method remains undecomposed by boiling even in a solution of 20° to 40° B. It is further claimed that the ferric sulphate prepared according to Knapp's method is more abundantly absorbed by the skin.

After tanning, the skins are treated with fat solutions and a so called iron soap. Greasing the skins by hand, hanging them up in the drying-room and scraping off the excess of fat is done away with. Stearin and paraffin are suitable materials for the fat solution.

The iron soap is separated in an insoluble form by precipitating soap solution with Knapp's ferric salt. The iron soap prepared in this manner is mechanically fulled into the skin, a fulling drum constructed by Knapp being used for the purpose.

A paste of iron soap is applied to the skin with or without an addition of fatty emulsions, or placed together with the skins in the fulling drum and mechanically fulled in. The skins are dried at the same time by the current of air passing through the fulling drum. The new and peculiar features claimed for this purpose by Knapp are as follows:

1. The preparation of the ferric salt, especially the treatment of the ferrous sulphate oxidized by nitric acid by a further addition of the same salt.
2. The treatment of the skins and hides with solutions of iron and fat.
3. The use of stearin for the above purpose.
4. The fulling drum connected with a fan by which a current of air is forced into it.
5. The iron soap and its use.

The advantages of this method of tanning are, according to Knapp—

1. Greater cheapness (from 5 to 25 per cent.).
2. Considerable saving of time, the product being of an equal quality and durability.
3. The obtaining of as large a yield as by tanning in the ordinary manner.
4. The use of a tanning material of a constant chemical composition, by which the obtaining of a uniform product is assured.

The leather prepared by Knapp's process had a brown-yellow color closely resembling that of leather tanned by the ordinary manner. It is, according to Knapp, not water-proof but capable of resisting water, meaning by this that the leather does not lose its tannin by frequent contact with water. As far as we know, this process was only used for the preparation of sole and belt leather, and we are unable to say whether upper leather was later successfully produced.

We will say nothing further *pro et contra* in regard to this method.

Knapp also applied for an additional patent for a somewhat different method of preparing the ferric salts. Instead of adding, as formerly described, nitric acid to a boiling solution of ferrous sulphate, an equivalent quantity of sulphuric acid and sodium nitrate is added to the ferrous sulphate solution. The tanning with this is effected in the same manner as previously described, but can also be done by the precipitate which albu-

minous substances, as for instance that of blood, produce with the ferric solution.

In the years 1880 and 1881, Heinzerling obtained patents in the United States, and previously in other countries, for quick tanning with chromates, with an addition of aluminium salts, sodium chloride, etc.

The process is executed as follows:

The skins are cleansed, depilated, and swelled, and placed in a one-quarter per cent. solution of chromic acid or in a half per cent. solution of potassium bichromate, sodium bichromate, or magnesium bichromate or other neutral bichromates, or in a half per cent. solution of chromic salts, for instance chromic sulphate. It is advantageous to add to the solution one per cent. of alum or aluminium sulphate or other aluminium salts, and one per cent. of sodium chloride. According to their thickness the skins remain in the solution a shorter or longer time; calf-skins, for instance, four to six days, and heavy bullock hides up to fourteen days. During this time the solution is successively concentrated until it contains as much as 6½ per cent. of chromates, 12 per cent. of alum, and 10 per cent. of common salt.

The action of tanning liquors gradually increasing in strength can also be effected in a more simple manner by placing the skins successively in more concentrated solutions and allowing them to remain a corresponding time in each of the solutions.

When fresh skins are placed in the tanning-liquors, the tanning substance withdrawn by the skins taken out must be always supplemented, the quantity required being determined by analysis.

Although experience has shown that the tanning process can be executed without the use of aluminium combinations and of common salt, it is advantageous to employ them, since these substances possess also tanning properties and accelerate the process, and besides being comparatively cheap, reduce the cost of the operation.

If leather is to be produced which is to be blackened after

tunning, 2 to 3 per cent. of potassium ferric-cyanide or potassium ferro-cyanide is added to the solution. These substances, together with the iron black applied later on, give a deep dark-blue color to the leather.

After tanning in the described solutions, the skins are placed in a 4 to 8 per cent. solution of barium chloride, acetate of lead, or soap, which effects a partial fixing of the tanning substance by the latter forming with the first insoluble salts or soaps.

To effect a quicker absorption of the barium chloride, acetate of lead, or soap, the skins, while in the solutions, are vigorously moved or kneaded. They are next washed, superficially dried and stretched, and, while still feeling somewhat moist, placed for 36 hours in a solution of stearin, paraffin, wax, rosin, colophony, spermaceti, or of other hydrocarbons or fat, in benzine or other solvents having a similar effect.

It is advantageous to heat the solution containing fat, paraffin or other hydrocarbons to 96.8° F. in a water-bath. In place of stearin or the other substances mentioned, a mass resembling caoutchouc can be used, which is obtained by treating oils (linseed or rape-seed oil) with 10 to 15 per cent. of chloride of sulphur. If chromic acid is used in tanning, the paraffin employed in the after-treatment is oxidized by the acid, the latter being at the same time reduced to chromic oxide. The paraffin appears to become oxidized to an acid-like combination which enters with the chromic oxide, formed into a combination insoluble in water, which is firmly precipitated upon the fibre. When chromates are used, the chromic acid is split off from the chromates during the tanning process, either by the skin itself, or, in case aluminium salts are employed, by the sulphuric acid liberated from them. By the succeeding treatment with paraffin, etc., the insoluble combination described above is also formed. As a proof of the described action taking place upon the paraffin, we would mention the fact that the cut surface of leather prepared according to the described process is at first yellow, but becomes gradually lighter, especially when exposed to the light, and turns finally to a nearly whitish-green. Metallic

salts, for instance cupric sulphate and others, can be added to the solution of chromates formerly mentioned, partly on account of the tanning effect of these salts, and partly in order to produce certain shades of color upon the leather.

The skins can also be placed, either before or after they have been treated with the described tannin liquors, in solutions containing vegetable tannin.

After the skins have been removed from the solutions of fat, paraffin or rosin, the leather intended for uppers and belts is greased in the same manner as leather tanned in the usual manner, with a mixture of tallow, train oil, or similar fat mixtures. After greasing, the fat is either fulled in or allowed to soak in by hanging the skins in a moderately heated room.

The upper leather is, generally speaking, curried in the same manner as leather tanned by the ordinary process, a few points only requiring special precautions to assure a fine product.

In preparing black grain leather, it is best to blacken the skins before placing them in the fat solutions. For blacking, on account of the yellow ground being more difficult to blacken, the application must be repeated once or twice oftener than for leather tanned in the ordinary manner.

If the leather is to be blackened after greasing and currying, the fat must first of all be thoroughly removed by scouring with dilute solution of soda or ammonia, and rubbing with pumice stone powder, or wood ashes. The grain side thus cleansed is then blackened with logwood extract or iron black.

Sole leather tanned by the above process is, after removal from the tanning liquor, impregnated with solutions of fat, wax, or rosin. It is then dried or rolled.

In working the upper and sole leather into shoes, the following directions should be observed: In order to be able to last the upper well, it should be placed in luke-warm soap-liquor for 10 to 12 hours and frequently kneaded. Lasting can only be accomplished in the ordinary manner after the fluid has thoroughly permeated the grain, which is more difficult to effect than with leather tanned in the usual manner. Chromium leather

it is claimed is more water-proof. The property of the leather of not stretching after having been worked, deserves special attention, since a shoe made a close fit, as is generally the case with leather tanned in the usual manner, is apt to be too tight.

For sole leather to be easily worked it is not sufficient to dip it simply in cold water; it should remain for some time in lukewarm water.

Experiments which have been made in regard to the absorption of water by leather tanned in the usual manner and that prepared with chromates, have shown that the latter absorbs water slower and a smaller quantity of it than the former.

A further advantage of chrome leather is that it possesses the property of losing less tannin by repeated treatment with cold or warm water than leather tanned in the usual manner.

The use of iron alum and chrome alum was at one time proposed and actually introduced into practice. But the use of these substances was soon abandoned, as the leather prepared in this manner had no advantage over that tanned with alum and alumina salts.

All the above-mentioned methods of tanning have been abandoned on account of the defective quality of the product produced by them. But this can scarcely be attributed to the properties of the tanning material, but rather to the errors committed in their preparation. By immersing leather prepared with these tanning materials in tan-liquor it was made closely to resemble that tanned in the ordinary manner.

While the experiments of Cavalin, Knapp, Pfanhauser and Heinzerling led to no immediate practical results, they were, nevertheless, of immense value, as laying the foundation for others, who came after them, to build upon. In seeking for this mineral tanning substance it was necessary that the new material should possess certain characteristics which would induce tanners to use it; namely, it should be obtainable in great abundance; it must be as cheap or cheaper than tannin; it should be quicker in its action, so that time might be saved; it should be as simple, safe and easy in its application as a de-

coction of tannin; it should produce a leather superior to that made by the older methods.

The salts of aluminium, iron and chromium, either, alone or in various combinations, were found to be useful in converting raw hides into leather, but the great majority of the processes covering the use of these metallic salts for tanning were found to be utterly impracticable, because lacking in one or more of the above-named essential characteristics. It remained, however, for American ingenuity to solve the problem. Through processes invented by Americans, all other metallic salts have been eliminated and the application of the salts of chromium has been made to fulfill all requirements. The two methods of chrome tanning now in practical use, and by which all chrome leather is made both in Europe and America, may be designated as the "two bath" process, patented by Augustus Schultz, and the "one bath" process, patented by Martin Dennis. The Schultz patents are owned by the Tannage Patent Company, of Philadelphia, Pa., who issue licenses to tanners and charge royalties for the use of the process. The Dennis patents are owned by the Martin Dennis Chrome Tannage Company, of Newark, N. J., who manufacture the chrome tannage material under the trade-mark of "Tanolin" and sell the material outright to tanners without licenses or royalties.

A detailed description of these two methods of chrome tanning is given in another part of this volume. In this connection, however, a description, in general terms, of the Schultz process and the Dennis process and a statement of what has been accomplished in the way of chrome tanning by these two methods will be of interest.

In the Schultz method, the skins, after being fully prepared for tanning, are immersed in a bath containing a solution of bichromate of potash and muriatic acid. This is called the "first bath," in which the skins remain until they have absorbed sufficient of the chromic acid. The skins are then placed in the "second bath," which is a solution of hyposulphite of soda, to which muriatic acid is added. The chemical reaction

in the "second bath" sets free sulphurous acid, which acts as a reducing agent upon the chromic acid in the skin, forming chromic oxide, which unites with the fiber of the skin converting it into leather. The proportions of bichromate of potash and acid in the "first bath" and of hyposulphite of soda and acid in the "second bath" have to be very carefully adjusted to a given amount of raw hide substance, which is determined by weight. To learn these proportions, as applied to different kinds of hides and skins, requires considerable experience obtained through practice. When Mr. Schultz first endeavored to draw the attention of tanners to his process it was severely criticised and was considered on all sides to be a difficult, complicated and dangerous process of tanning. It was not until Mr. Robert H. Foederer, of Philadelphia, and Mr. Wm. Zahn, of Newark, N. J., made commercial leather which was considered superior to any heretofore produced, that any serious consideration was given to the Schultz process. At the present time the process is largely used in the production of glazed kid and for certain classes of glove leather; in fact the American chrome-tanned glazed kid is conceded to be the most beautiful fabric ever produced for use in the making of ladies' shoes. Not only do the American shoe manufacturers use the chrome-tanned glazed kid almost exclusively, but large and increasing quantities of this leather are being exported to European countries.

By the Dennis "one bath" process the art of chrome tanning has been greatly simplified. A dilute solution of a basic or oxy-salt of chromium is used in which the chromic oxide is held so loosely that it readily yields this oxide to the skins placed in the solution. In fact the skins absorb the chromic oxide from the solution in the same manner as the skins would absorb tannin from a bark liquor. In the Dennis process the skins are not subjected to a drastic chemical reaction, nor are they exposed to the action of corrosive acids, which in other processes often produces irreparable damage to the resulting leather. Tanolin is the name given to the Dennis one-bath

chrome tan liquor, and it is designed to afford leather manufacturers an easy, cheap and reliable method of producing chrome leather. It is offered to tanners in a compact, convenient and concentrated form, all ready for use. Tanolin has no smell and will not even stain the hands; it is handled in a simple, straightforward manner, in much the same way as a bark, gambier or sumac liquor. Any tanner of ordinary experience can handle tanolin with confidence and safety. No change or special fitting up is required in a tannery in order to use it, and the usual apparatus and appurtenances found in a well-appointed tannery are all that is required for the successful use of tanolin.

The advantages obtained by the use of tanolin must be obvious to any unprejudiced tanner, but they are enumerated below to give emphasis to the point;

First. The tanning is accomplished in one bath.

Second. The tan-liquor is clean, without stain or smell, and can be handled by workmen without risk.

Third. The tanning material is all prepared for use, and does not require an expert to prepare the tanning bath.

Fourth. The tanner can handle the chrome liquor as he has been accustomed to handle sumac or gambier liquor.

Fifth. The tan liquor can be modified in its application so as to tan slowly or quickly as it is desired.

Sixth. It can be used successfully in paddle wheels, revolving drums, or in vats with rockers.

Seventh. The tan liquor does not lose strength, change character or turn sour on exposure, and can be kept indefinitely.

Eighth. The old liquors can be used and exhausted, so that great economy can be attained in the cost of tanning.

Ninth. The chrome leather is produced without the risk attending the use of corrosive materials and acids as in other processes, and, therefore, the results obtained are more uniform and reliable.

Upon these and many other considerations it is claimed for the Dennis "one-bath" process that it is the easiest, safest,

cheapest and most reliable system of chrome tannage yet devised.

The Dennis process, without doubt, offers to tanners a most inviting field for exploitation, and one can hardly realize what changes may be wrought in the future by this method of chrome tanning. It is surprising what has already been accomplished with it in its application to the production of various kinds of leather. The author would mention that he has seen the following varieties of leather tanned by this process, and all of them of the very finest quality: Machine belting, made by Geo. F. Troutwine & Co., Gloversville, N. Y.; harness leather, made by The J. G. Hurkhamp Co., Fredericksburg, Va.; hard sole leather, made by D. M. Easton, East Weymouth, Mass.; upper leather, made by Hayes & Co., Belvidere, N. Y.; glove leather, made by Brower & Dodge, Gloversville, N. J.; glazed kid, in blacks and colored, made by Lennox & Briggs, Haverhill, Mass.; chamois leather, from fleshers, made by the Enterprise Chamois Works, Philadelphia, Pa.; picker band leather, made by Prakke Bros., Eibergen, Holland; patent and enamel leather, made by S. Halsey & Son, Newark, N. J. The Dennis process is simple, cheap, quick and reliable. In this day of enterprise and activity tanners are forced to leave old ruts and to keep thoroughly posted on every new process and improvement likely to prove of advantage and profit to them.

The modern tanner cannot stand still—the whole world teaches us that. Electricity is driving out steam power, compressed air is likely to drive out electricity as a power, and aerial navigation is no longer a dream, but a reality. To stand still is to be passed by more enterprising men and completely distanced in the commercial race.

Of course tanners in embarking in the new field of chrome tannage will have to have their wits about them.

Men who are not practical in the business, such as curriers of bark leathers, should be replaced by men specially competent for every department. A superintendent, thoroughly practical in every detail, should be untrammeled in his operations.

With competent men in charge, there is no reason why fancy colored chrome, glazed calf and imitation kangaroo should not be turned out with entire success. American morocco and kid manufacturers are at the top of the ladder, and manufacturers of chrome and combination calf and sides should adopt their methods. They are worthy of emulation.

Foreign methods of working, that is, foreign to the business, have been chiefly responsible for failure in getting out merchantable kids. For instance, take the question of shaving and putting out skins. It is a mistake to stick to the old currier style of shaving on the wooden beam-face. It has been turned down by the regular men in the business a century ago. Its defects are not so noticeable in dull or kangaroo finish as in glazed black or fancy colors. It is utterly impossible for a shaver to do good work on a wooden beam, from the fact that it cannot be kept in proper working order. So long as there is any hand shaving to do, the glass beam-face is the proper one to use.

Skins should be put out on a morocco table and by a regular morocco dresser. It is very important to put out fancy colors, chrome, calf and imitation kangaroo from calf and kip, tight.

Chrome tannage is increasing rapidly in use and favor. There is an attraction in this method of making leather that is almost fascinating. Many leading tanners have been using chrome tannage for a long time, but during the past year tanners all over the country have been quietly experimenting with chrome liquors on upper and sole leathers.

Chrome upper, both in black and colors, is remarkably tough and pliable. It is astonishing how strong and supple even light skins may be made by chrome liquors. Chrome tannage makes leather comparatively fireproof, which is a feature of much value. During wet or cold weather people are in the habit, on returning indoors, of pushing their shoes near heat or fire. Bark-tanned leathers are very sensitive to heat, and liable to burn readily. Shoe manufacturers and wholesalers are fre-

quently troubled by shoes returned with burnt uppers. Those who bought and wore such shoes, thoughtlessly placed them near the fire, and then found the leather damaged. Without referring to the application of heat, they boldly accused the storekeeper of selling them inferior shoes, and worried him into replacing them with a new pair. The storekeeper in turn passes the burnt shoes to the firm from whom he bought them, demanding recompense or duplication.

Chrome-tanned leathers may be boiled for several minutes with impunity, or exposed to strong heat for some time without injury. The process is not specially new, but has been much improved. Pioneers made and lost fortunes in it. To-day, however, chrome tannage is much better understood, and instructions and material are obtainable by which those previously ignorant of it may be guided with safety to success.

Although chrome tannage has thus far been applied chiefly to goatskins, it is becoming considerably used on kip, calf, and even side-leathers. It is beginning to compete with bark. Bark tanners are encouraged to experiment with chrome, foreseeing many advantages in the saving of labor, etc. Chrome tannage takes shorter time and does away with bark piling, cost of insurance, interest, etc., on bark stacks, grinding, leaching, and the labor and expense connected with leach houses.

Those who are tanning sole leather by the chrome process have every reason to be gratified at results. The pretty leather seems to be ideal material for the bottoms of shoes for cycling, athletics, etc., being light in weight, delicate green or greenish-blue color, very tough and pliable. Chrome leather is also excellent for slippers, Goodyear insoles, for soft shoes required by old people, and invaluable in hospitals, etc., where noiseless tread is necessary.

While tanners are paying close attention to chrome, their demands are being met by concerns that either furnish the instruction, or supply the chrome liquors ready for use.

The popularity of cycling, golf and other outdoor sports has given marked impetus to the demand for what are known as

sporting shoes. Shrewd shoe manufacturers, foreseeing the broadening field of athletics, have prospered by studying the requirements and supplying the wants of this field rather than sticking to the old and familiar staple lines. Those who are manufacturing sporting shoes seem quite satisfied not only with what they have done so far, but with the outlook for the future. All who take pleasure in outdoor sports and recreation are willing to pay a fair price for the necessary boots and shoes, and are not very particular as to the shape or trimmings. The pedestrian or runner avoids "razor toes." Such men favor common-sense lasts, and do not ask for changes in style, but rather that their shoes be strong, durable and comfortable.

The growing enjoyment of outdoor exercise is proved by the fact that many leading hardware houses have established departments for the sale of sporting goods, including shoes. Their customers, particularly those from the country, like to get these supplies at one place, and the enterprising merchants strive to accommodate them. For a long time hardware and seed stores have carried cut soles, many of them disposing of quite a quantity of leather in this manner each year.

Manufacturers of boots and shoes for sportsmen and athletes are fortunate in having to confine their solicitations either to the better class of retail stores or other desirable distributors. The smaller shoe dealers do not expect any of this kind of business.

It cannot be denied that much of the pleasure on land or water may be made or marred to a considerable extent by one's boots and shoes. Consequently, while there may be economies in clothing, active, healthy men and women do not grudge what might be called liberal expenditure in covering their feet. The ever-ready and alert shoe manufacturer who has studied the art of making the right kind of shoes for cyclers, athletes, hunters, fishermen, etc., is finding his reward to-day. And his trade will grow according to the comfort, quality and judicious advertising of his product.

Some of the leading sole-leather tanners, noting the new trend of trade, are studying to increase the supply of chrome

tanned sole, as it is apparent that this leather is excellently adapted for the peculiar toughness and pliability needed in shoes for cycling and other purposes.

There is an increasing demand for bicycle, golf, athletic and sporting shoes. The manufacturers are beginning to pay attention to this new feature of their trade, and the result is that there are several styles of such shoes now on market.

In his advertisement a prominent New York dealer says: "My lines of bicycle shoes are designed with the utmost care for comfort and style, and every important point is considered as carefully as in the manufacture of the highest grade wheel."

This seemed to us putting it rather strong, and, in a recent conversation, the advertising manager of the house said to the writer: "The advertisement states the truth, for we do consider every point about the shoe with all possible care. We are trying to make a reputation for our bicycle shoes. We want the trade of bicyclists, both men and women, and, if we can become known as the makers of the best bicycle shoe, it should result in a growing and profitable business. The time to make that reputation is at the start and before other makers take the lead."

Bicycle, golf, athletic and sporting shoes should be soft, strong, fine and durable; they should be easy on the feet and handsome in appearance. The sole leather for these shoes should be made from steer hides, and the shoes should be tough, elastic, and noiseless. Chrome tannage seems to be the only way known of treating the hides so that these desirable results can be produced.

TANNING CALF OR GOATSKINS BY THE CHROME PROCESS.

The Martin Dennis Chrome Tannage Co. publish these directions for using tanolin on calf or goatskins. This is the "one-bath" process:

1. On removing the skins from the bran drench it is well to mill them in a drum in a pretty strong solution of alum and salt.

The use of the alum and salt, however, is optional. The object in using the alum and salt is to keep the skin open and plump, to prevent them from drawing on the grain and to keep the skins during the process of tanning in such condition that they can be worked and set out with a slicker after being tanned, without having that spring to the leather which a good many complain of in working and currying chrome leather.

2. Take the skins from the alum and salt solution, and place them in a bath containing a 3 per cent. solution of tanolin, to which a liberal quantity of common salt is also added.

3. As the skins absorb the tanolin, the tanning liquor will become lighter in color. To strengthen the liquor add more of the concentrated tanolin to the tanning bath, a quart or a gallon as the case may be, but always enough to maintain the color of a 3 to 4 per cent. solution. It is advantageous from time to time to correct the tanolin liquor by adding to it slowly and carefully a solution of sal soda prepared in the proportion of 1 pound of sal soda to 3 gallons of water. This soda solution may be added until the tan liquor begins to appear cloudy; then stop. This procedure will render the tan liquor so sensitive that it will yield to the skins the whole of the tanning material. By correcting the liquors as above indicated, the old liquors may be made over and over again by simply adding more tanolin with each new pack, so as to maintain the color of a 3 to 4 per cent. solution. When the skins have assumed a uniform greenish blue color, and by wringing the neck of a thick skin it wrings out dry, and by cutting a section of the part wrung out the skin appears fibrous throughout, the skins are tanned.

4. On removing the skins from the tanning bath, they should be rinsed off in clean water to remove the adhering liquor; not washed for any length of time, but simply rinsed off. The skins should then be struck out on the flesh side with a slicker; the tables used for this purpose should be perfectly clean and free from any grease or oil, so that the grain may be protected from any extraneous substances, for in this condition the grain

of the skins will absorb stain or grease easily and quickly, and interfere afterwards wirh the coloring.

5. After striking out the skins should be shaved, remembering during the shaving to protect the grain from stain or grease.

6. The shaved skins can then be stained, fat-liquored, colored, set out, etc., dried, staked and finished in the ordinary way.

TANNING SHEEP SKINS BY THE CHROME PROCESS.

The Martin Dennis Chrome Tannage Company give the following directions for preparing sheep and lamb skins for tanning by their one-bath process:

1. The skins should be wrung or pressed to remove the animal grease, and then milled in a solution of common salt and water to open up and soften the fibres of the skin.

2. If pickled skins are to be tanned, it is better to remove the pickle before commencing the tanning operation, with a drench of "C. T. Bate," or, if this preparation is not at hand, with a drench of bran and salt.

3. The skins should then be given a bath of alum and salt in the proportion of 1 to 2 lbs. alum and about 5 lbs. salt to the dozen skins. The use of alum and salt, however, is optional. The object in using it is to keep the skins open and plump, to prevent them from drawing on the grain, and to keep the skins during the process of tanning in such a condition that they can be worked and set out with a slicker after being tanned, without having the spring to the leather already referred to. From this point the tanning of sheepskins is the same as the tanning of calf and goat skins above given.

SOME PATENTS FOR CHROME TANNAGE.

It is now an established fact that chrome-tanned leather has secured a recognized place as an important article of production, and when its peculiar and superior qualities become more generally known to the public, the demand for this mineral-tanned leather will largely increase. Believing as we

do that chrome leather is a thing that has come to stay, and feeling confident that the future is full of promise to the tanner who masters the art of producing this leather, we have obtained the following information regarding the Dennis "one bath" process of chrome tannage, in order that our readers may become acquainted with one of the methods of chrome tanning which is already largely in use and which has found favor with tanners all over the world.

For four years tanolin has been sold in the market as a tanning material, and during that time it has achieved a wide reputation and reached a large sale. This is not to be wondered at, because the various "two-bath" methods of chrome tanning are more or less complicated, perplexing and uncertain, and the desirability of obtaining an easier, simpler and more certain method was conceded on all sides. The tanolin without doubt accomplishes this, and removes the difficulties inherent in other systems of chrome tanning to a remarkable degree, affording the tanner a method of changing from "the old to the new," which is simplicity itself. It may be said that the "one-bath" system opens up a much wider application of the chrome tannage, and at present it seems safe to predict that at no very distant day nearly all classes of leather will be tanned with chrome.

The German tanners have taken hold of the matter of chrome tanning with great earnestness and have applied it to the production of a great variety of leathers. The German is by nature an investigator and is, moreover, endowed with an amazing degree of patience and perseverance; and the consequence is that when he takes up with a new thing he turns it upside down and inside out until he discovers all there is to it, and if it proves to have merit, he is quick to adopt whatever may be to his profit and advantage. So it has been with tanolin, the German recognizing from the start that the "one-bath" method of chrome tanning had many advantages over the complicated "two-bath" system. The English are also waking up to the possibilities of mineral tannage and are giving considerable

attention to it, though they have not accomplished so much in this direction as the Germans.

Until recently the chrome tannage has been almost entirely confined to the production of light shoe leathers from goat skins, but since the introduction of tanolin nearly all sorts of hides and skins have been tanned with chrome and finished in a great variety of ways for almost all the uses to which leather is put. It is interesting to note what has already been accomplished with tanolin by clever, enterprising tanners.

In view of the things already accomplished, it is difficult to foretell where these new and modern processes of tanning will lead us. Of one thing we are certain, and that is that it brings a benefit to all concerned; to the tanner, because it enables him to produce leather cheaper and quicker; to the consumer of leather, because he is furnished with a better and more durable article.

THE DENNIS TANNING-LIQUOR.*

This invention relates to a liquor to be used in the tanning of leather, and is described by Mr. Dennis as follows:

It consists of a novel composition of matter in a liquor for tanning hides or skins in the method known as chrome tanning, and the method of making the same.

In an application filed by me on the 3d day of October, 1892, Serial No. 447,695, I have described and claimed the use of this liquor, which is the subject matter of this application, in tanning hides, and this application has, therefore, no reference to the methods of using this liquor, but relates solely to the composition of the liquor itself and the method of making it.

It has long been known that chrome oxide has the property of combining with the hide gelatine to form an insoluble and non-putrescent body, and is, therefore, capable of converting hides into leather. It has only been during the last few years, however, that commercial leather has been made by the so-called chromic tannage, and there is still much room for improvement.

* Patented by Martin Dennis, Newark, N. J. United States Patent, No. 511,411.

The difficulty standing in the way of the use of chromic oxide as a tanning agent has been its insolubility in water, and the consequent difficulty in getting the chromic oxide into intimate contact with the hide or skin to be tanned. Attempts have been made to overcome this difficulty by the use of chromic alum as a tanning agent, but without practical success. When chromic alum is used deoxidation or reduction is unnecessary, since the chromium exists in the alum in the form of an oxide; but as chromic alum is a very stable body and gives up its chromic oxide with great difficulty, the process of fixing the hide gelatine by its use is exceedingly slow, unsatisfactory and expensive. This difficulty has in a measure been overcome in some processes, by impregnating the hide or skin with chromic acid and then reducing this chromic acid to chromic oxide in the substance of the hide by the use of some reducing agent, as, for example, sulphurous or oxalic acid, sulphureted hydrogen or protosulphate of iron. The chromic acid in these processes is usually introduced into the hides or skins by immersing them in a bath to which bichromate of potassium and a strong acid like hydrochloric acid have been added. Chromic acid, however, is a powerful oxidizing and corrosive agent and invariably does more or less injury to the hide or skin, and, unless it is handled with very great skill and caution, will produce leather which will become hard and crack, and exhibit other defects. In fact the utmost care and experience often fail to prevent the finished leather from showing the destructive effect of this powerful corrosive agent. One of the probable causes of the deterioration of leather made by the use of chromic acid is that chromic acid itself appears to enter to a greater or less extent into some sort of combination with the hide gelatine, in which combination it is not wholly reduced to chromic oxide by the sulphurous acid or other reducing agent employed, but after the leather is finished and placed upon the counter or manufactured into shoes, the oxidizing and destructive effects of the chromic acid become manifest by its losing its strength and suppleness and becoming hard and brittle and papery to

the touch. The unsatisfactory action of chromic alum in tanning and the destructive effect of the chromic acid upon the fiber of the hide and skin, therefore, renders it highly desirable to employ some method of chrome tanning which will be quicker and cheaper and more satisfactory than the use of chromic alum, and which will not necessitate the bringing of the hide or skin into contact with these strong and corrosive acids. The object of my experiments was, therefore, to discover some method of introducing chromic oxide to the hide or skin, to be tanned in a water-soluble, neutral and unstable combination, that is, to discover some chromic oxide compound soluble in water, in which the chromic oxide would be held loosely, that is, in an unstable combination, and which compound, when dissolved, would be practically neutral, and I have succeeded in doing this by my invention, which I will now describe.

It is well known that when to solutions of a number of the normal salts of chromium is added a quantity of a more powerful base, a part of the acid which was combined with the chromium base is taken away and the chromium base is left in a combination which may be regarded as basic, that is, containing two or more equivalents of the metallic base or oxide to one of the acid, and when in this condition the excess of the metallic base or oxide over what the acid would hold in the normal salt is readily yielded to any body having an affinity for it; that is, the excess of the metallic base over what would be present in the normal salt is held in an unstable combination with the normal salt. While this is a well-known chemical fact, it was not known prior to my discovery or invention that any commercial use could be made of this chemical property of the salts of chromium in chrome tanning.

In preparing my tanning liquor according to this invention, I utilize this property of chromium salts. I have found chloride of chromium best adapted for my purposes, although other inorganic salts of chromium may be used with more or less succes, and I prefer to use chloride of chromium in practicing my invention, and shall use it hereinafter in illustrating the same.

In practicing my invention, I first prepare a solution of common chloride of chromium. This may be done by dissolving the commercial oxide of chromium in commercial hydrochloric acid, which has been diluted with an equal bulk of water, care being taken to use more chromic oxide than the acid will take up, in order that the resulting solution may be as nearly neutral as possible. About eight ounces of the commercial acid is sufficient to dissolve a pound of commercial oxide of chromium. When this reaction is complete I have the normal salt of chromium, known as the chloride of chromium, in solution. In order to render this normal salt of chromium a basic salt, I add slowly and carefully to this solution a solution of a more powerful base, continuing the addition to a point where the normal salt has been practically rendered entirely basic. This point will differ in different cases, depending in a measure on the strength of the solutions, but the addition should not be carried beyond the point at which the oxide of chromium begins to precipitate, and the amount of base to be added can be readily ascertained in each case by making a small experimental mixture. I may use for this more powerful base any of the caustic alkalies or the carbonates of these alkalies, but I prefer to use either caustic soda or the carbonate of soda, or, as the latter is known in trade, "sal soda." And when this is used it may be added until rapid effervescence ceases. It usually takes about half a pound of sal soda crystals to each pound of chromic oxide, dissolved as above. When this reaction is complete, it will be found that the carbonate of sodium has changed the normal chloride of chromium into an oxy or basic chloride of chromium. This may be considered as consisting of a normal chloride of chromium and chromic oxide in a water-soluble combination, free chromic oxide, hydrated or otherwise, being insoluble in water. This oxy or basic chloride of chromium is a very unstable body, giving up its excess of chromium oxide whenever there is presented to it a body or substance for which chromic oxide has an affinity, as, for instance, hide gelatine. There exists also in this solution, when the last reaction

is completed, a quantity of chloride of sodium formed by the union of a part of the acid which was in combination with the chromium in the normal salt of chromium with the sodium base of the carbonate of sodium. This chloride of sodium serves the useful purpose of preventing the grain of the leather from drawing under the astringent effect of the chromium salt and facilitates the tanning action, and to further effect these purposes I also add to this solution a few pounds more of chloride of sodium (common salt). When I use any of the alkalies or alkaline carbonates that do not contain soda, I prefer to add to the solution common salt. When this has been done, my tanning liquor is complete and ready for use in the manner indicated in my aforesaid application.

I am aware that others have added carbonate of sodium to the solution of a chromium salt, but in all cases where this has been done, only so much carbonate of sodium has been added as would serve to take up the free acid in the solution of the chromium salt, and thereby neutralize the solution; and in no case has carbonate of sodium been added to the solution of the chromium salt in an amount sufficient to effect or change the chromium salt in any particular, or for that purpose, while in my invention that is one of the principal objects of adding the carbonate of sodium, as my solution is practically neutral before its addition.

The tanning liquor produced by this invention is cheaper and more quickly and easily used than a liquor made from chromic alum; is practically neutral, has no corrosive action on the hides, and is free from all offensive odors, in these particulars as well as others being a marked improvement on all known tanning liquors.

In the foregoing specification and in the claims to follow, the term basic is meant to include metallic salts, which contain more than one equivalent of the metallic base to one equivalent of the acid, as above described; and in the claims, the term carbonate of sodium is meant to include its chemical equivalents for the purpose specified.

The word "tanning" is meant to include all methods of fixing or rendering insoluble the so-called gelatine of the hides or skins, for the purpose of converting them into leather.

My invention consists broadly in a method or process of making a tanning liquor containing a basic or oxy-inorganic salt of chromium and the product of that process.

Specifically, it includes a method or process of making a tanning liquor containing a basic or oxy-chloride of chromium and chloride of sodium, and the product of that process.

THE DENNIS PROCESS OF TANNING LEATHER.*

This invention relates to the manufacture of leather.

It consists of a novel method of fixing the so-called gelatin of the hide or skin by means of a metallic oxide, and has for its object the cheapening and simplifying of the process of making mineral tanned leather, as well as the improvement of the manufactured product, and is described as follows by Mr. Dennis:

It has long been known that chromic oxide has the property of combining with hide gelatin to form insoluble and non-putrescent body, and is, therefore, capable of converting hides into leather. It has been but a few years, however, that commercial leather has been made by the so-called chromic tannage, and there is still much room for improvement in this kind of leather as placed at present on the market. In my process chromic oxide is presented to the hide gelatin in the state of a soluble combination in which it is so loosely held that it is readily given up to the gelatin, rendering the fixing of the latter both rapid and complete. The soluble combination which I use is designated by chemists as a basic or oxy salt. When to solutions of a number of the normal salts of chromium is added a quantity of a more powerful base, a part of the acid which was combined with the chromium base is taken away and the base is left in a combination which may be regarded as basic, that is, containing two or more equivalents

* Patented by Martin Dennis, Newark, N. J. United States Patent, No. 495,028.

of the metallic base or oxide to one of the acid. In this case the excess of metallic base over what the acid would hold in the normal salt is readily yielded to any body having an affinity for it. The effectiveness of my method, as far as the mere fixing of the gelatin is concerned, lies in bringing the latter in contact, in a neutral or nearly neutral solution, with a chromic oxide so held as to be readily taken up by the gelatin. This result is accomplished by solutions of the combinations which I have called basic salts of chromium, and they furnish the only practicable means of presenting to the hide gelatin, chromic oxide in soluble form and yet not in stable combination with acids. When hides or skins, properly prepared, are treated with a solution of one of these basic chromic salts the gelatin quickly takes up the excess of the chromium base, (in combination with which it is insoluble,) and leaves only the remaining normal salt in solution.

Attempts have been made to use chromic alum for converting hides into leather, but without practical success. When chromic alum is used, deoxidation or reduction is unecessary, since the chromium exists in the alum in the oxide form; but as chromic alum is a very stable body, and gives up its chromic oxide with great difficulty, the process of fixing the hide gelatin by its means is exceedingly slow and unsatisfactory.

The central idea upon which the practicable methods of chromic tannage, other than mine, are based, is to impregnate the hide or skin with chromic acid, and then to reduce this acid to chromic oxide in the substance of the hide, by means of some reducing agent, for example sulphurous or oxalic acid, sulphureted hydrogen or protosulphate of iron. The chromic acid is usually introduced into the hides or skins by immersing them in a bath, to which bichromate of potassium and a strong acid like hydrochloric have been added. Chromic acid, however, is a powerful oxfdizing and corrosive agent, and invariably does more or less injury to the hide or skin, and unless it is handled with very great skill and caution will produce leather which will become hard and crack and exhibit other defects.

In fact the utmost care and experience often fail to prevent the finished leather from showing the destructive effect of this powerful chemical agent.

One of the probable causes of the deterioration of leather made by the use of chromic acid is, that chromic acid itself appears to enter to a greater or less extent into some sort of combination with the hide gelatin, in which combination it is not wholly reduced to chromic oxide by the sulphurous acid or other reducing agent employed, but after the leather is finished and placed upon the counter or manufactured into shoes, the oxidizing and destructive effects of the chromic acid become manifest, by losing its strength and suppleness and becoming hard and brittle and papery to the touch.

It is true that the above method, as far as fixing the gelatin is concerned, although it is done in acid solution, is very effective. In fact it is, outside of mine, the only practical way known of occomplishing that result. This effectiveness is due to the fact that chromic oxide (which is the real fixing agent) is formed by the reduction of the chromic acid while in actual contact with the hide gelatin. Therefore the gelatin can take up the chromic oxide while in the so-called "nascent" state, and thus accomplish in a solution, what it could not easily do if the oxide were not formed in direct contact with it; for instance, as when the hide is treated with an acid or even neutral solution of a normal salt of chromium. But the destructive action of chromic acid on the fiber of the hide or skin (particularly when the highest skill is not employed) renders it extremely desirable to use a method in which the hide is not exposed to the action of chromic acid or other destructive chemical agent, or to intensely acid solutions of any kind, but in which the chromic oxide is brought in contact with the hide gelatin in a nearly neutral and mild solution, and yet in a form in which it can be easily and quickly taken up. All this is accomplished by my method, which I will now describe.

The salt of chromium which I have found well adapted for my purpose is the chloride, although other salts might be used,

and this I use to illustrate my process in the following description: I first prepare a solution of common chloride of chromium. This may be done by dissolving the pigment known as chrome green, and which is hydrated oxide of chromium, in commercial hydrochloric acid which has been diluted with an equal bulk of water, care being taken to use more chromic oxide than the acid will take up, in order that the resulting solution may be as nearly neutral as possible. About eight ounces of the commercial acid are sufficient to dissolve a pound of commercial hydrated oxide of chromium. To this solution of chloride of chromium I add slowly and carefully a solution of a more powerful base, and for which purpose I prefer carbonate of sodium, or as it is known in the trade, "sal soda," until precipitation of chromic hydrate begins, or if carbonate of sodium is used, until rapid effervescence ceases. It usually takes about one-half pound of sal soda crystals to each pound of chromic oxide dissolved as above. I now have a nearly neutral solution of oxy or basic chloride of chromium. It may be considered as consisting of the normal chloride of chromium and chromic oxide in soluble combination (free chromic oxide, hydrated or otherwise, being insoluble in water), and a quantity of chloride of sodium formed by the union of a part of the acid which was in combination with the chromium, with the sodium base of the carbonate of sodium, and which also serves a useful purpose, which will be mentioned later on. The hides or skins, after having been suitably prepared by soaking, liming, unhairing, bating, washing, &c., are immersed in the solution of the oxy or basic chloride of chromium prepared as above, and of a strength of about three gallons of the concentrated solution to one hundred gallons of water. To the solution is also added, besides that formed by adding carbonate of sodium to the solution of chloride of chromium, a few pounds more of chloride of sodium (common salt) for the purpose of preventing the grain of the leather from drawing under the astringent effect of the chromic salt, and to facilitate the tanning action. The treatment of the hides or skins in the above solution is accomplished

in a "paddle" or other equivalent apparatus, as it is quite necessary that they be frequently moved in order that the action of the chromic salt may be uniformly distributed. According to the thickness of the skins and the strength of the solution, this tanning process requires from about ten to forty-eight hours. Ordinary goat skins for the so-called dongola leather do well by running them in the paddle during the day, then allowing them to stand over night in the liquor, and run the paddle about an hour in the morning, when the skins will be found well tanned. The strength of the chromic solution may be varied according to the thickness of the skins, and may be strengthened from time to time during the tanning operation if necessary. After the absorption of chromic oxide has ceased, and all the gelatin of the hide has been rendered insoluble by its combination with the chromic oxide, which condition is readily recognized by one familiar with leather making, the skins are washed in clean water, and are then agitated in a bath containing finely-divided carbonate of calcium or its equivalent.

Instead of carbonate of calcium, carbonate of barium or the carbonates of lead, zinc, etc., may be used. When carbonate of calcium is used, the form known in commerce as whiting is well adapted. The object of agitating the skins with these carbonates, which are insoluble in water, is that every kind of acid present may be neutralized without subjecting the skins to the action of an alkaline bath. The skins may now be again washed, after which they are ready for the so-called fat-liquor, for drying previous to dyeing, or for any other of the processes belonging to the currier's art.

As my invention does not appertain to the beam-house work, by which the hides or skins are prepared for tanning, and which would be substantially the same for my process as for any other method of tanning or tawing, I will not specify any particular procedure for that part of the tanner's work. Neither is it necessary to give directions as to the treatment of the skins after they are removed from the bath of suspended carbonate of calcium, for it is as various as the different uses to

which leather is put, and does not belong to the realm of tanning proper, with which alone my invention has to do.

Among the advantages possessed by my method may be mentioned the following:

First, The tanning or fixing of the gelatin is effected entirely in one bath, instead, as in the old methods, of impregnating the skins with a chromic acid in one bath, and then reducing the chromic acid to chromic oxide in another bath. Thus the labor of one handling is saved.

Second, The skins are not exposed to the destructive action of chromic acid, whereby the leather is stronger, has much more suppleness which it long preserves, shows a better grain, and does not become tinny or papery, as compared with the product of the ordinary method of chromic tannage.

Third, There are no offensive or suffocating smells evolved, as when in the ordinary methods the chromic acid is reduced to chromic oxide by the use of sulphurous acid or sulphureted hydrogen.

Fourth, Since my tanning bath is entirely non-corrosive, there is no danger of allowing the skins to remain in it too long, and not nearly so much skill and care are necessary as in the old methods.

Fifth, Not only is there a saving in labor in my process, but my tanning bath is much cheaper than those of the old methods, since the chromic oxide in my tanning bath costs much less as prepared by me than as prepared from bichromate of potassium and a reducing agent in the old methods.

Sixth, The tanning is effected in my process in a bath, which is not strongly acid, as is always the case in the old methods, in which chromic acid is employed. This nearly neutral bath is of great advantage to the skins, and naturally assists the currier in the subsequent work of dyeing and finishing the leather.

In the foregoing specification and in the claims to follow, the term basic is meant to include metallic salts, which contain more than one equivalent of the acid, as above described, and

in the claims, the terms carbonate of calcium are meant to include their chemical equivalents for the purpose specified.

The word "tanning" is meant to include all methods of fixing or rendering insoluble the so-called gelatin of the hides or skins for the purpose of converting them into leather.

The gist of my invention consists broadly in the use, as a tanning agent, of a basic or oxy salt of chromium. Specifically it includes the use as a tanning agent, a basic or oxy-chloride of chromium. It also includes a tanning bath prepared by adding to a solution of chlorfde of chromium, carbonate of sodium, or its equivalent, until the chromium salt is rendered basic. Further, it includes the use of a bath for tanning containing both basic chloride of chromium and chloride of sodium. And lastly, it includes the process of subjecting hides or skins, in which the gelatin has been fixed by treatment with oxy or basic chloride of chromium, to the action of a neutralizing bath of suspended carbonate of calcium.

We are aware that by publishing the Dennis patents in full we have had to make many repetitions, but this could not be avoided, as we wished to make the chrome tannage fully understood, even if we have had to resort to tautology in doing it.

F. E. Atteaux & Co., Boston, Mass., Sager Chadwick, Philadelphia, Pa., Samuel P. Sadtler, Philadelphia, Pa., George W. Adler, who sold his patent to the Eureka Tannage Co., Philadelphia, Pa., Hugo Schweitzer, New York, N. Y., have all recently invented one- and two-bath processes of chrome tannage.

The patents issued to Augustus Schultz and William Zahn are given in full in the next chapter.

CHARACTERISTICS OF CHROME LEATHER.

Chrome leather has special and peculiar qualities which distinguish it from all other kinds of leather, and these special features cause it to be a superior fabric for all the purposes for which leather is used. It has been often stated that chrome leather is waterproof, but this is not a proper term to use in

connection with it; it should more properly be called non-absorbent. All kinds of leather produced with tannin absorb water readily, like a sponge, while chrome leather does not absorb the water but resists it or sheds it, like the feathers of a duck; in fact it is a difficult matter to thoroughly wet through chrome leather when it is once dry. Again, water and air are the agencies in nature which promote decomposition and decay, and as tannin and hide substance are both organic materials, and when combined, as is the case in bark-tanned leather, and subjected to a process of wetting and drying, such leather will eventually but surely deteriorate and become rotten.

Chrome leather, on the other hand, being a combination of an inorganic material with the hide substance, and subjected to the same process of wetting and drying, shows no effect whatever; in fact, the oftener chrome leather is wet and dried the softer and more flexible it becomes. Even subjecting it to boiling water apparently has no effect upon it, while any sort of leather produced with tannin and placed in boiling water is utterly destroyed; moreover, chrome leather is of much lighter weight than bark leather, and this is a decided advantage for almost all purposes for which leather is used. On this account considerable attention is being given to chrome leather by foreign nations for military accoutrements. It seems that a soldier, fully equipped, carries six pounds and more of leather about him, and if this weight can be decreased one-half, his efficiency in marching will be increased; if shoes can be made of less weight and more durable and afford complete protection for the feet from wet, such shoes will be a wonderful improvement over those at present in vogue. Harness made from chrome-tanned leather would be much lighter in weight, would not be affected by the perspiration of the horse, nor deteriorate by exposure to the weather. Chrome-tanned machine belting could be run in wet and damp places without fear of resulting damage or injury to the belt. Experiments made in the testing of chrome leathers indicate: 1st, that chrome leather excels in strength; 2d, that after reaching the stretching limit with a

corresponding load, it possesses still a considerable degree of elasticity, which is of great value as regards the adhesion of belts to pulleys. One of the immediate possibilities of the future is that chrome-tanned gloves will be demanded by the public in preference to all others, simply because when such gloves become soiled they may be washed upon the hands with soap and water until cleansed, and when dried will be as soft and flexible as before washing.

CURRYING CHROME LEATHER.

In the currying of chrome leather some modifications both of methods and materials are required as compared with the usual methods employed on bark leather. In the first place chrome leather does not require nor will it absorb and hold as much oil and grease as bark leather; in the second place, the chrome leather should be curried and stuffed soon after removal from the tanning bath, while it is still wet and before drying out, because if dried out immediately after tanning it is almost impossible to wet down the leather thoroughly and uniformly, so that it can be properly stuffed and curried. Probably the most efficient means of incorporating oils and greases in chrome leather is by means of "fat-liquors," so called. There are various ways of preparing and using these fat-liquors, according to the quality it is desired to give to the leather. The fat-liquor in most general use is an emulsion of soap and oil, preferably a potash soft soap and a fine quality of neats-foot oil, used warm and in a dilute form and milled into the leather by means of a pin-mill drum.

Other preparations are recommended, such as an emulsion of degras and egg-yolk, and also an emulsion of egg-yolk and olive oil. These fat liquors seem better adapted for lubricating the fibres and nourishing the leather than the hard greases and heavy fish oils which are used on bark leather. They impart to the chrome leather the necessary strength and flexibility without rendering it greasy and smeary.

TO PREPARE CHROME-TANNED LEATHERS FOR DYEING.

A patent has been granted to E. Avellis and Emil Köster, both of Berlin, Germany, for an improved method of preparing chrome-tanned leather for dyeing.

According to the patentees, their invention has for its object the preparation of chrome-dressed leather, so that it may be dyed in any desired shade or tint with aniline colors, and consists in first freeing the leather from acid, and subsequent treatment with materials containing tannin, although, in order to obtain a clear tint, it will be found expedient to re-tan the leather thus prepared with tartar emetic, or with preparations of the same.

The following practical example will make the process clearer:

In order to free 225 pounds chrome-tanned leather from acid, mix, in about 100 quarts of water, 7 pounds whiting and 5 pounds ordinary salt, washing the leather in this solution for about a quarter of an hour, until all trace of acid has been removed, which may be determined by means of blue litmus paper. Next, rinse in water to remove the chalk.

Following the foregoing process, the leather, deprived of acid, is treated with materials containing tannin. When divi-divi is used, 2¼ pounds of the latter in a solution of 1 to 2 deg. Beaumé to 225 pounds leather is a very effective proportion, and a correspondingly weakened solution may be employed for light tints.

Although the leather thus prepared may be dyed at once, it is however, advisable, in order to obtain clearer tints, to first re-tan with tartar emetic.

The proportions recommended for the purpose are: For chrome-tanned sheep leather and kid, 15 grains tartar emetic to 3 quarts liquor for each skin; for calfskins, 22 to 30 grains to 6 quarts liquor (according to size of skin); cowhides, 100 to 150 grains for 10 to 18 quarts. The tan liquors are used at 96° F., the leather being allowed to remain in the wheel or fulling mill from 5 to 8 minutes; it is then rinsed in fresh water, and then dyed the desired color in vat or drum.

DYEING CHROME LEATHER.

Chrome leather is easily dyed, and takes all shades of color most readily. If the neutral basic aniline colors are used, it is necessary to mordant the leather with some wood-dye, and then color to shade with aniline. For very light shades a weak decoction of sumac may be used; for medium shades a fustic liquor, and for dark shades a mixture of fustic and logwood may be used as a mordant,

It is said that the acid aniline colors dye directly without the use of a mordant; very recently, it is claimed that the chrome leather may be dyed successfully with alizarine colors.

In order to fix alizarine colors in leather, it is necessary to apply considerable heat; for this reason they are not applicable to the ordinary tanned goods. Chrome-tanned leather will, however, stand a high temperature without the slightest damage, and for this reason good results are to be had with alizarine dyes.

The use of alizarine colors in powder form is not generally known to the leather manufacturers, but when it becomes so it will prove a great boon, as they produce full bright colors that are fast and dye very evenly.

Alizarine dyes have a great affiinity for the oxide of chrome, in fact, require a chrome mordant, viz.: bichromate of potash and an assistant of organic acid like lactic acid to produce the oxide of chrome. Inorganic acids, like sulphuric, muriatic, or even oxalic, should not be used, as they have a tendency to affect the leather, producing bad results.

Lactic acid when free from adulterations, about 30 degrees strength and used with bichromate of potash, makes the best "all-round" mordant to be used on leather, regardless whether the same be tanned with chrome, vegetable material or alum, or whether the dye-stuff be wood, anilines, or alizarines, and the method of dyeing employed is that of coloring on the table, in the box, paddle or drum.

The application of alizarine to fibres other than those of vegetable origin is of comparatively recent date, and even ten

years ago alizarine colors on wool were practically unknown. When, however, through the breaking up of the alizarine syndicate, alizarine was brought into the market at a low price, wool dyers began to direct their attention to this and allied coloring matter, with the result that at the present time large quantities of them are used in the production of fast shades on loose wool, stubbing and yarn. That their superiority over other coloring matters is recognized by merchants, and probably also by the public, is revealed by the fact that special prices are sometimes quoted for alizarine-dyed goods, as distinct from such as are dyed with other coloring matters.

The application of the alizarines in silk dyeing is of still more recent date, and although the demand has hitherto been restricted to embroidery, yarns, sewing silks, and stripes for trouserings, the colors have latterly been used for silk plush, for seals and for producing fast fancy shades.

The usual method adopted in wool and in silk dyeing is to first mordant the material with salts of chromium, iron, aluminium or tin (for wool, chrome is principally employed). After washing off or soaping, the material is immersed in the cold or lukewarm dye-bath, and the temperature is gradually raised to the boil and kept at that point until the bath is exhausted. The actual formation of the color lakes only begins at 194° F., and is completed between this temperature and the boiling point in from twenty minutes to half an hour.

In the case of leather dyeing with these materials this procedure is, of course, impossible, except for chrome tanned leather, from the fact that leather tanned with organic tannins will become rotten if exposed to a higher temperature than about 122° F. for any length of time. The solution of this difficulty has been found by H. Koechlin and E. Knecht, who adopt a principle previously applied to wool. They first pad the leather with a solution of alizarine rendered slightly alkaline with ammonia, and then develop in solutions of alumina, chromium, or iron salts. If the pieces are dried after having been padded in the alkaline color solution and are then printed

with thickened acid or stannous chloride, a variety of white or colored figures can be obtained on colored grounds. If, for instance, the goods, padded in the ammoniacal alizarine solution and dried, are printed with stannous chloride and then passed through pyrolignite of iron, an orange pattern is obtained on a violet ground.

In the practical application of this principle to leather dyeing, the comparatively strong, slightly ammoniacal alizarine solution (or nitro-alizarine, a solution of the monosodium salt, as the case may be) is first applied to the leather by means of a brush or pad, and the color lake is then formed by a subsequent treatment in the mordant solution. Since it has been found that ordinary alum or nitrate of iron is liable to precipitate a considerable amount of unchanged alizarine in the leather, it is preferable to use these salts as basic as possible; but it is evident that the process when properly applied, ensures the production of a large variety of useful and fast alizarine shades on leather without incurring any damage to the material, and this is one more victory to the credit of science in the art of leather manufacture.

CHAPTER XXIII.

KID OR MOROCCO LEATHERS.

THERE has been a greater revolution in morocco manufacturing in ten years than in all the centuries of its existence. Skins were formerly tanned with sumac, gambier or alum. The new agent, chrome, was introduced in 1884. This was the most important event that ever occurred in the history of the trade —perhaps in any trade. From this material better kid was made than any that had been imported. Its use forthwith reduced the import of foreign morocco seventy per cent. From being importers we became large exporters of this leather. The qualities of chrome-tanned kid, such as imperviousness to water, firmness and softness, together with the peculiarity of looking better in the shoe than before it was made up, caused its universal adoption. All its merits were examined and freely discussed in the meetings of the Morocco Manufacturers' Association. The committee advocated its adoption and spent much time in seeking to remedy some of the early defects in the tannage.

On January 8th, 1884, two patents were issued to Augustus Schultz, of New York City, by the United States Patent Office, for tawing hides and skins. These letters patent are Nos. 291,784 and 291,785, and are later on described in this chapter. Augustus Schultz was, at the time application was made for these patents, an employee of the firm of William Pickhardt & Kuttroff, New York, N. Y., and at first lived in Hoboken, N. J., but moved to a house which Mr. Pickhardt had purchased at No. 135 East 15th St., New York, for the purpose of fitting up for patents which he possed for ventilating and heating. His residence is now near Manassas, Virginia. He is

64 years of age. Mr. Schultz made all of his experiments in glass goblets, of large size, of which he had a half dozen or more.

He knew of no tanner in those days except Julius Kuttner, in the employ of Booth & Co., of Gloversville, N. Y. Mr. Schultz asked Mr. Kuttner if he knew of anything that would be of advantage to the leather trade, and he replied that it would be desirable to find something that would replace the egg yolk which his firm was using for finishing their leather. Mr. Schultz tried to find a substitute for egg yolk; but this experiment was a failure, and Mr. Schultz then commenced the experiments in tanning leather in 1880, and he continued these experiments until his two patents were issued in 1884.

The reason which Mr. Schultz gives for taking out two patents is that Dr. Antisell, who was that time Examiner in the U. S. Patent Office, would not allow hyposulphite of soda to come into the patent with the fumes of sulphur and the sulphite of soda.

Many tanners of kid leather use only the process described in patent No. 291,784, which provides for the use of hyposulphite of soda.

On the 15th day of June, 1891, Augustus Schultz sold, assigned and transferred to Ludwig Roth all his interest in both of said patents; and on the 30th day of November 1891, Ludwig Roth assigned said patents to Ferdinand Blumenthal, Ludwig Roth and Julien S. Ulman, constituting at that time the firm of F. Blumenthal & Co., New York City and Wilmington, Del.

On December 15th, 1891, the firm of F. Blumenthal & Co. was dissolved by mutual consent and by the retirement of Ludwig Roth, and the two patents were transferred to the firm of F. Blumenthal & Co., composed of Ferdinand Blumenthal and Julien S. Ulman. On the 16th day of June, 1892, the firm of F. Blumenthal & Co. assigned the two said letters patent to Marcus Beebe and Robert H. Foerderer, who in turn, on the 30th day of August, 1892, assigned the two said letters patent to the Tannage Patent Company, of Philadelphia, Pa., who still

own them. The patents will expire on the 8th day of January, 1901.

The superior qualities of chrome tanned leather are its great strength, its insolubility in water, its susceptibility of being finished in various ways and colors, and its excellent wearing qualities. Leather made by the chrome process, while being exceedingly soft and pliable, is less liable to stretch than leather made by other tannages, in other words, shoes made of chrome leather, after being worn for any length of time, will retain their size and shape to a remarkable degree. This was not the case with leathers tanned by any of the well-known processes practiced prior to the date of the Schultz patents. There are reasons which make it of great advantage to the tanner to use the chrome process.

William M. Norris says: "The class of goods which was turned out up to the introduction of the Schultz patents ceased to be called for by shoemakers, and manufacturers were obliged to turn their attention to the newer mineral tannages with a glazed finish. French kid was the standard of excellence, and the aim of experimenters was to reproduce this as nearly as possible. The methods of tanning this leather in France, as nearly as could be ascertained, were to tan or taw the skins with alum, salt, flour and egg yolk, dry them out, and lay them away for six months or so before finishing. This 'ageing' or 'laying away' was essential in order that the alum should 'set' and be rendered somewhat insoluble, or, in other words, that the soluble sulphate of alumina in the alum should be converted into the insoluble oxide.

"This process was altogether too slow for the American manufacturer, and also the price leather tanned by this process commanded was not sufficient to recompense him for the large stock necessarily carried and the large capital required to conduct the business.

"About this time it was discovered that gambier used in connection with alum produced leather that could be finished at once, without laying the stock away for several months, and

also that the finished product was strong, handsome, and would stand more wear than the imported article.

"This alum and gambier, or so-called 'Dongola' tannage, is entirely an American process, and has been brought to great perfection during the last few years.

"While French kid was only made into high-priced shoes, which were naturally taken care of by the purchaser and worn in the house or only out-doors in fine weather and on city pavements, the American Dongola leather, owing to its lower cost, was made into all grades of shoes, some of which sold at a very low price and which were subjected to hard wear during inclement weather, often in muddy country roads and on rough, uneven pavements. This soft kid leather is not adapted to rough wear and did not give satisfaction when subjected to it. Shoes, when soaked, were apt to dry out hard and unpliable, and the grain was apt to peel off when brought in contact with rough stones or subjected to the constant wear of ladies' dresses. Shoe manufacturers became more and more exacting in their demands. They wished a gloss or finish that was water-proof, leather that would stand a good wetting without injury, and which had a tougher grain, and so there has been a marked falling off in the demand for 'Dongola' leather, and the product which now seems to fill the requirements of shoe manufacturers is produced by the so-called 'acid' or 'chrome' process of tanning.

"We are indebted for this tannage, not to the numerous inventors and their impracticable processes, but to a young morocco manufacturer of Philadelphia. This gentleman had in his office a few dozen skins of a celebrated French manufacturer. From frequent examinations of these skins he became convinced that there was an indescribable something about them that was entirely wanting in the domestic article. He endeavored to produce stock like it, and was understood by his neighbors to be using chrome as a tanning agent. For several years his efforts resulted in few successes and many discouragements, but finally he perfected all the difficult and

minute details of his process, and was enabled to place a most superior product on the market. He ran his factory to its utmost capacity, and then moved to a larger and more commodious one, where, to meet the demands of the trade, he constantly increased his production until it reached the enormous and unprecedented quantity of a thousand dozen skins a day.

"If it had not been for the wonderful success of this Philadelphia manufacturer, little would be heard of chrome or chrome-tanned leather to-day.

"It has long been known that the salts of chromium have a strong affinity for gelatine, and form with it insoluble compounds, and therefore have tanning power; but it was not until very recently that these salts of chromium were employed in the manufacture of leather with success.

"All the salts of chromium may be used for tanning, as well as bichromate of potash, or magnesia, chromic acid, and bichromate of ammonia, aluminium and iron.

"But so far manufacturers have generally confined their attention to bichromate of potash, as this is the most widely known of the chromium salts.

"Potassium bichromate, generally known as 'bichromate' or 'bichrome,' is manufactured in large quantities from chrome iron ore, or chromite, by the action of some oxidizing agent. This important mineral is found in large quantities near Baltimore, Md., in Norway and the Shetland Islands off the coast of Scotland, as well as in Asia Minor, Siberia and Australia.

"Bichromate of potash crystallizes in anhydrous, fine red, square tables, specific gravity 2.7, and is of intensely metallic taste; 100 parts of water at 32° F. dissolve 4.6 parts, at 60° F. 12.4 parts, and at 212° (boiling) 94 parts.

PREPARING THE SKINS.

When the dry goat-skins are removed from the bales, they are placed in the "soaks," which are vats containing clear cold water, and remain for from three to five days, the period of

course depending upon the condition of the skins, the hardest requiring a longer soaking than those that are softer. Five pounds of borax is added to each 1,000 gallons of water in the "soaks;" the borax being first dissolved in boiling water and then thoroughly stirred into the water of the "soaks." (See Chapter VI.)

From the "soaks" the skins are removed either with hooks or tongs, and placed, usually 150 to 200 at one time, in the "pin-mill," which is a softening contrivance, and when sufficiently softened the skins are next placed in the "limes."

In many kid tanneries it is the custom to break or flesh the skins after they come from the "soaks," the machine shown in Fig. 95 being especially adapted for this purpose.

Fig. 94 shows a view of the lime-vats, in a kid or Morocco tannery, and over one of the pits is shown a pile of skins which have been removed therefrom and placed upon planks to drain, while in the background is shown the "wash-wheel." Above each lime-vat there is a small blackboard upon which are marked in chalk the number and kinds of skins in each vat and the date on which they were put in.

In large Morocco tanneries usually 1350 South American goat-skins are limed at the same time, and about 600 glove-calf, and 800 glove-sheep are placed in separate vats at once.

The goat-skins remain in the "limes" about 14 days, glove-calf 12 days, and glove-sheep 8 days. The lime is mixed with red arsenic, as this agent losens the fine hairs better than any other. (See Chapter VII.)

They then go on to the unhairing machine shown in Fig. 95, or to the unhairing beams, and are unhaired by hand, and one man will "unhair, flesh, and slick" about eighty skins per day.

The machine shown in Fig. 95 can be used not only for unhairing, but for breaking, fleshing and slating, and is equally adapted to goat, sheep, calf and kangaroo skins. It requires but one operator to each machine, and is economical in space and power required to operate it, and is guaranteed by its

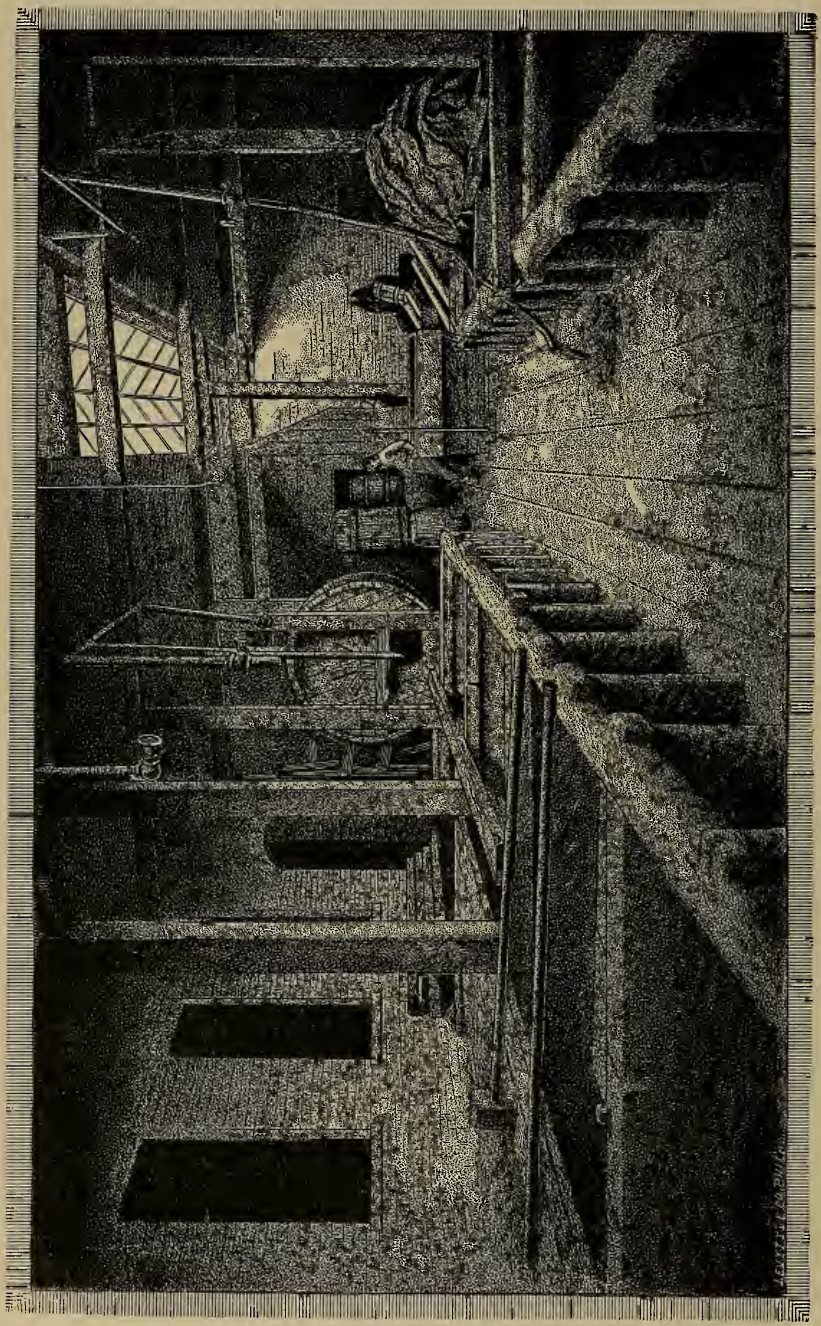


FIG. 94.

LIME-VATS IN A KID OR MOROCCO TANNERY.

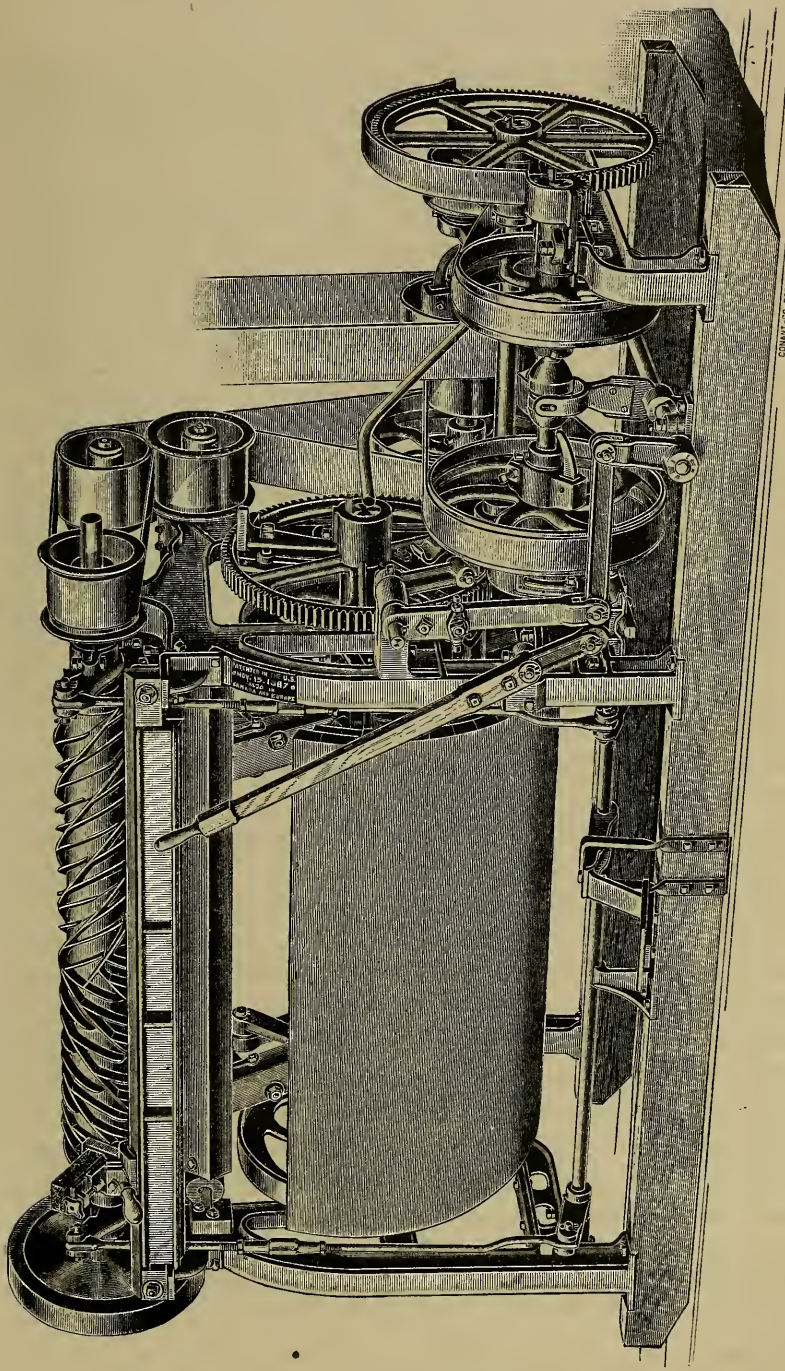


FIG. 95.

BREAKING, FLESHING, UNHAIRING AND SLATING MACHINE.

builders, Vaughn Machine Co., Peabody, Mass., to do better work than can be done by hand or any other machine, and at the same time quantity enough to suit anybody, whether doing a large or small business.

The Vaughn Machine Co. have thoroughly remodeled and perfected this machine in every detail. It is the only machine that will break or flesh skins in the hair from the soaks before being limed, which is an important thing to be done on all hard-natured or very fleshy skins, as thereby the scale and all superfluous flesh are removed, the skin thoroughly spread out and softened, and put into the most desirable condition to go into the limes. For unhairing it is very useful and profitable, as it will do an immense quantity of good work and without any damage whatever. For fleshing it is perfection, doing the work cleanly, evenly, and without any tearing or damage whatever; the machine being so completely under the control of the operator that there is no danger in fleshing the most delicate skin, while on heavy stock it will cut down as much as is wanted; therefore, making a great saving in tanning materials and shaving. For slating nothing can equal it, as the skin is being worked both lengthways and sideways by the cylinder at the same time, the dirt and fine hairs being thoroughly worked out and with absolutely no danger of grain scratches. This invention is a great labor and time saver. It is operated by one man, and performs the work of a dozen men.

It is impossible to do any of the above-named work in any other way nearly as well as it can be done with this machine. The principle of the machine is an absolute guarantee of this, for the bed or beam on which the skin lies is carried over and back under the cylinder, so that it is worked both ways at one operation, and also that the operator sees just what is wanted to be done to each skin as it goes through, and then just how the work has been done as it returns to him. This insures perfect work on each skin before it leaves the machine.

After being unhaired the skins are placed in a mill and thoroughly washed with water and borax to free them from adher-

ing lime and dirt, and are next placed in the slightly-heated bate of dog or pigeon manure, in which they remain over night. (See Chapter IX.)

The character of the leather produced by any of the chrome processes is greatly influenced by the previous treatment of the raw pelt. It must be remembered that all chrome tannage is necessarily light-weighing and empty, since the quantity of chrome oxide fixed is far smaller than in the case of vegetable tannins. It is, therefore, of great importance, if plump leather is required, that the natural substance of the hide or skin should be spared as much as possible in liming and bating or puring. The liming is best accomplished in 'arsenic limes' in the case of light goods, or with the addition of ½ pound or more of sulphide of sodium per hide in ordinary limes. Where a smooth grain and plump leather is important, chemical deliming is much to be preferred to the use of fermenting bates or drenches. Use a solution of 2 per cent. boracic acid and 1 per cent. of good carbolic acid in water, frequently after first 'pulling down' by paddling in warm water to which about ¾ pound of sulphuric acid and 2 ounces of sal-ammoniac is added per 100 pounds of wet pelt. When the goods come out, this solution should test slightly alkaline to red litmus paper, and if this is not the case sufficient ammonia should be added to make it so, and the goods paddled in it another half hour; and in future operations the amount of acid must be reduced. The boracic acid bath may be used repeatedly; goods will keep in it even for months without change. If limey goods are treated in it without previous 'pulling down,' it may be made slightly acid to litmus paper with hydrochloric or sulphuric acid each time before using, the strength being also maintained by small additions of boracic and carbolic acids. In this solution the goods become quite free from lime, but remain pretty plump and full, and if tanned in chrome liquor which is not too strong at first, and without too violent motion, remain perfectly smooth in the grain.

Upon removal from the bate the skins are "slated," which is

the removal of the fine hair remaining upon the skins after the unhairing operation. The machine shown in Fig. 95 can be used or the hand method may be employed; the "slater" is a tool closely resembling a "slicker," but the edge of the "slater" is ground sharp.

The skins are now passed into the bran drench, which is composed of bran and water, slightly heated, and in this they remain usually over night and are then finally washed with borax water.

TAWING.

If the skins are to be tawed according to the Schultz patent, they are immersed after the final washing with borax and water in a bath containing about five per cent. of the weight of the skins of bichromate of potash, and about two per cent. of hydrochloric acid, since this amount of acid is sufficient to enable the skins to absorb the liquor; the skins are placed in a reel, with sufficient water to enable them to freely rotate by means of the action of the paddle-wheel; the skins are left in this solution until this yellow liquor has thoroughly penetrated the skins, and have assumed an even yellow color all the way through, which is determined by cutting pieces from the thickest part of the skin, and when this even yellow color shows evenly through the skins, they are ready to receive the second bath. After removing the skins from the first bath, the skins are allowed to drain, or, in order to expedite matters, the surplus liquor is sometimes pressed out before putting them into the second bath. A bath is then prepared of about ten per cent. of hyposulphite of soda of the weight of the skins, and about two and a half per cent. of hydrochloric acid, and sufficient water to enable the skins to float by the same mechanical means as described in the first bath; the skins are placed in the second bath, and allowed to remain therein until they assume a whitish, bluish or greenish color all the way through. This is also determined by cutting pieces from the thickest part of the skin; and when the yellow color has entirely disap-

peared, the skins are done; this completes the tanning. Some of the stock is put on the market with no further treatment other than mechanical. Some of the stock is finished in various ways, in black and fancy colors and dull and glazed surfaces, and any treatment subsequent to that of tanning is based entirely upon the result obtained for the purpose for which the leather is to be sold.

Skins are frequently tanned in baths constituted in different proportions of the materials as given. The proportions are varied according to the character of the skins and the product desired. Sometimes as high as eight per cent. of the weight of the skins of bichromate of potash and five per cent. of hydrochloric acid, and as low as three per cent. of bichromate of potash and one per cent. of hydrochloric acid. There is no necessary hard and fast rule that must be followed.

Neither is there any hard and fast rule that must be followed in regard to the amount of water used, or in other words in regard to the degree of concentration of the baths. On this point the greatest latitude is permissible. As a matter of fact, tanners vary this according to the apparatus which may be most convenient for them to use; when skins are treated in the first bath in a drum the liquor is very much more concentrated than when treated in a reel. In treating skins in a drum, the skins are placed in a drum together with the tanning liquor; the drum is securely closed and then caused to revolve, and the action caused thereby causes the skins to be raised in the drum and then fall back, which has a pounding action upon the skins and causes any liquors that are present to be rapidly absorbed. In a drum, a comparatively small amount of liquor is used, because, if a large amount of liquor is used the mechanical action of raising the skins and allowing them to fall back would not take place, and the skins and the liquor would remain at the lowest point, while the drum would revolve without causing agitation of the mechanical action that would facilitate the absorption of the liquor by the skins. The reel is a vat made in a semi-circular shape, in the centre of the top

of which is mounted an ordinary paddle-wheel. In order to procure the mechanical action desired, it is necessary to use an amount of liquor in the reel such that the blades of the paddle extend a sufficient depth into the liquor. The action desired is to cause the skins to be constantly rotated or agitated in the liquor, in order that every part and portion of the skins may be brought in contact with the liquors, and that the skins should not remain in a folded position where the penetration might not be even and uniform. For the reasons given, it is customary to use more liquor and the baths are less concentrated when treating skins in a reel than when treating them in a drum. The only difference in the two methods is that in the case of tanning in the drum penetration is accomplished quicker and in less time than when tanned in a reel. The result in the product, however, is exactly the same.

The reel and drum described above are well known forms of apparatus used by tanners for tanning hides and skins. The hydrochloric acid above mentioned is the same as muriatic acid, and ranges from twenty to twenty-two degrees and is added to the bichromate of potash after it has been thoroughly dissolved, which is done by heating the water and the above specified weight of muriatic acid is then poured into the vat. The second bath is prepared after dissolving the hyposulphite, the muriatic acid is added, usually two to two and a half pounds to one hundred pounds of skins, and after stirring this thoroughly the skins are placed in this bath; the acid being of the same degree as in the first bath. The hyposulphite of soda after dissolving and being placed in this bath can hardly be noticed; as soon, however, as the muriatic acid is added the color changes to a bluish green and creates sulphurous acid which can be detected at once by the smell, and it is as much as one can do to stand it. This bath changes the color of the skins from a yellow to a bluish white.

It is not known what the chemical reactions are which take place when the skins which have been treated in the first bath (patent No. 291,785) are subjected to the action of the second bath.

It is evident from the change in color that a change takes place in the condition of the chromium of the first bath; it is evident that what the chemist calls a reduction takes place. Some oxygen is taken away from the chromium compound, and the yellow compound of chromium containing much oxygen is changed to a green compound which contains less. This is about as much as is definitely known with regard to the chemical reaction.

The bichromate of potash has no effect upon the skins whatever, and the only object in soaking the skins in the bichromate of potash is to have the bichromate of potash in the proper place at the proper time when the actual process of tanning is to begin. The tanning always takes place in the second bath. Here certain chemical changes take place between the material contained in the second bath and the bichromate of potash and the skin. There is no special significance in the word "bath." "Bath" is nothing but a solution, and all you can say is that previous to the date of these patents, skins had been dipped into a solution of something else, such as chloride of barium. In this case these two substances acting upon each other, produced a yellow powder, consisting of chromate of baryta, which fills the pores of the skin.

The essential discovery made by Schultz was that an improved leather resulted from the action of the agents which liberate sulphurous acid upon metallic salts, such as bichromate of potash in the pores of the skin. He further discovered that still better results could be obtained by selecting hyposulphite of soda as the agent to be used in connection with the bichromate of potash.

It cannot be determined exactly what the chemical reactions are which take place in the skins, when a bath containing sulphurous acid acts upon the bichromate of potash, and when a bath containing hyposulphurous acid acts upon the bichromate of potash. Sulphurous acid is one thing; hyposulphurous acid is another. It is true that hyposulphurous acid undergoes decomposition and produces sulphurous acid, but that is

not all it produces. It produces finely divided sulphur, and it is very probable that the action of the hyposulphite of soda involves more than the action of sulphurous acid alone. At all events, it is said to give better results in practice, so there must be some advantage in it even though it may not be known what chemical actions occurs.

It is known that hyposulphurous acid will often accomplish results in chemical reactions which sulphurous acid alone will not accomplish.

The operations involved in carrying out the process set forth in patent No. 291,784 are the same as in patent No. 291,785 until we come to the preparation of the second bath described in the last mentioned patent. In this case the skins coming from the first bath are treated in a second bath, which consists of a solution capable of evolving sulphurous acid, such, for instance, as a solution of sulphite or bisulphite of soda, together with some acid stronger than sulphurous acid, such as hydrochloric acid. The skins are allowed to remain in this bath until the change in color induced by the liberated sulphurous acid, (and which may be to a whitish or blush or greenish color according to the thickness of the skins, and consequently the time required to complete the action,) has penetrated through them. They may then be removed and finished after the ordinary manner.

Some people have regarded the two patents above mentioned issued to Augustus Schultz as deficient or even partially misleading in their descriptions. This is not so, as the directions given are sufficiently full, clear and exact to enable any person skilled in the art to which the patents relate, to successfully carry out the processes, and result in the production of a useful product. Any person skilled in the art, upon taking up these patents with a desire to put them in practical operation, would have no difficulty in understanding either the object at which they aim or the means set forth for the attainment of that object, or of the materials which may be used, or of the manner in which they may be employed.

In tanning goat-skins for kid leathers the skins remain in the first bath for about one-half day, and sometimes longer, if upon examination they were found to be not thoroughly tanned; this examination being made by cutting the neck of the skin and seeing that no animal or raw material is left.

The skins are left in the second bath until no show of bichromate or yellow is apparent. This process, by some tanners, is applied to the skins in the afternoon, and they are allowed to remain in the liquor of the second bath over night. Sometimes the skins are needed as quickly as possible, stock that has been actually sold or is needed for order is required, and instead of leaving the skin in the second bath over night, they are washed and rushed right along. The time that the skins remain in this bath, under such circumstances, is only for a few hours, the time depending of course upon the thickness of the skins under treatment.

It has been demonstrated in practice that the use of sulphuric acid in the first bath and muriatic acid in the second bath would not prevent the carrying out of the Schultz process and making, by the aid of it, leather.

This was tested practically by Professor Samuel P. Sadtler on January 4, 1894, at the tannery of Burk Bros., in Philadelphia, Pa. He took a goat skin from the regular stock of prepared skins the skin weighing about twelve ounces. It was put in a bath of one hundred and twelve fluid ounces of water, three-quarters of an ounce of bichromate of potash in crystals, and one-half an ounce of strong sulphuric acid. The skin was entered at 11 : 50 a. m. at a temperature of 87 degrees F. for the bath. It was taken out at 3 : 25 p. m. after testing it for penetration in the usual manner. It was then struck out or freed from excess of moisture, and at 3 : 45 p. m. it was entered into a bath of hyposulphite of soda, one and three-quarter ounces, and one-half an ounce of muriatic acid of 21° Baumè, dissolved in the same amount of water as that of the first bath. It was taken out after testing it for completion of the reaction at 5 : 15 p. m., and was struck out. It was then put in fresh water over night. The result was good merchantable leather.

The sulphuric acid of commerce usually contains a percentage of hydrochloric acid sufficient for the work.

In patent No. 291, 785 Mr. Schultz says: "An aqueous solution of sulphurous acid may be used." This undoubtedly means that in place of the two chemicals which are first prescribed as to be taken for the evolution of sulphurous acid, an aqueous solution of sulphurous acid could be taken of such a character as to accomplish substantially the results intended by the use of the mixed sulphite of soda and muriatic acid.

Strong acid solutions would undoubtedly have an injurious effect upon the hide, of course that injurious effect would continue into the leather produced. The skins would be swollen very rapidly in a relatively strong acid bath, and in that swollen condition the penetration of the bichromate salt, if the first bath be referred to, or the penetration of the chemicals of the second bath, equally would be hindered to a very considerable degree; and at the same time, in addition to this swelling or "plumping," as it is termed, the acid is steadily disintegrating the fibre, acting upon the connective tissue of the hide, as it is termed.

The plumping is a surface indication of the effect of the acid, and it undoubtedly preceded the other effect, that is, opening up or partially dissolving the connective tissue; and while some plumping always takes place at stages of the tanning proceeses, excessive plumping is to be avoided, and in this case it is especially to be avoided, for the reason that it would prevent the penetration of the salts which are to be the effective tanning agents in the Schultz process.

When a skin is introduced into an acidulated bath and the skin plumps, that bath contains too much acid. This may be noticed in the difference between the effect of neutral bichromate of potash solution and acidified bichromate of potash solution. In the neutral bichromate of potash solution the skin retains for a long time the soft, slimy feeling of the hide, and in the acidified bichromate of potash solution even with very small amounts of acid, there is a distinct surface roughening which

might be termed an incipient plumping, but which has no notable effect in the way of injury.

The tan vat used in the two-bath method of chrome tannage is 7 feet long, 5 feet 6 inches wide, and 5 feet deep. Semi-circular to within 1 foot of top, where it is plumb up. Over this vat there is a revolving wheel 5 feet 6 inches long and 3 feet in diameter. This wheel has 7 wings in it; they are 2 inches thick and 9 inches deep.

There are at least two of these vats in each morocco factory where the chrome process is used, that is, the two-bath process.

SPECIFICATION OF SCHULTZ'S FIRST PATENT (NO. 291, 784).

This invention, says Mr. Schultz, relates to a new process for tanning hides or skins, said process consisting in subjecting said hides or skins to the action of compounds of metallic salts—such as bichromate of potash—and then treating the same with hyposulphite of soda, by which term is understood that salt which is more recently sometimes called "thiosulphate of soda" ($Na_2S_2O_3$).

In carrying out my process, I unhair the raw hides and prepare them in the same manner in which they are made "ready" for tanning. If the hides have not been pickled, I subject them to the action of a solution of bichromate of potash in the presence of an acid, such as hydrochloric acid, or, if the hides have been pickled, they may be treated in a solution of bichromate of potash in water without the addition of an acid. In this solution the hides are left for a shorter or longer time, according to their thickness and to the strength of the solution employed. A skiver or the face of a sheepskin can be done in a strong solution, as above described, in about fifteen minutes, while a full skin "roan" would require in the same solution about one hour. I call the solution "weak" if it contains 5 per cent. or less of the weight of skins of bichromate of potash, and I call the solution "strong" if it contains more than 5 per cent of bichromate of potash. It is not material, however, how strong the solution is. The skins are completed if small pieces

cut from the thickest part of said skin show that the solution has entirely penetrated. The skins are then ready to be taken out, and after the adhering liquor has run off, the skins are introduced into the second solution, which consists of hyposulphite of soda dissolved in water, and adding an acid such as hydrochloric acid. The solution may be strong or weak of hyposulphite, and the quantity of acid used at first may be less than requisite to split up the entire quantity of hyposulphite, and more acid may be added if the skins show that more is required, which is indicated by the color of the skins. When they are done they show a whitish, bluish or greenish color, according to the time they are kept in the hyposulphite solution. A skiver which has first been exposed to the action of the bichromate for fifteen minutes will be ready by remaining in the hyposulphite solution about twenty minutes. For thicker skins a proportionately longer time is required. For some skins, such as calf or steer's skins, it is desirable that the same, after having been drawn from the second or hyposulphite solution, shall be returned to the bichromate solution, which imparts to them a brownish color, and leaves them in a favorable condition to be colored black. The coloring can be done after the skins leave the hyposulphite solution, and after they have been exposed the second time to the bichromate solution. The leather coming from the hyposulphite solution is especially adapted for light or dark colors, and by proper dyeing methods better and brighter colors can be produced than on leather done by tanning. After the leather is treated in the manner above indicated, it may be colored, soaped and greased in the usual way. Leather can also be made by reversing the operation and first soaking the hides in a solution of hyposulphite of soda, and then exposing them to the action of the bichromate solution. By using the solutions indicated at a heat of 80° Fah., the process will be done in a shorter time than if the solutions are used cold. By my process the gelatine contained in the hides is rendered insoluble by means not injurious to the leather. If leather made by tannin is put in a

strong soda solution, the tannin is extracted and a dark-brown liquor formed. If leather made by my process is put in a strong soda solution, the liquor obtained shows only a little milky color. Leather made by my process is very strong, soft, elastic, and my process is applicable to hides or skins of every description.

SPECIFICATION OF SCHULTZ'S SECOND PATENT (NO. 291,785).

This invention, says Mr. Schultz, relates to the new process for treating hides or skins, said process consisting in subjecting said hides or skins to the action of a bath prepared from a metallic salt—such as bichromate of potash—and of then treating the same with a bath containing sulphurous acid.

In carrying out my process I unhair the raw hides and prepare them in the same manner in which they are made ready for tanning. If the hides have not been pickled, I subject them to the action of a bath of bichromate of potash in an acid, such as hydrochloric acid; or, if the hides have been pickled, they may be treated in a solution of bichromate of potash in water without the addition of an acid. In this solution the hides are left for a longer or shorter time, according to their thickness and to the strength of the solution employed. A skiver or the face of a sheepskin can be done in a strong solution, as above described, in about fifteen minutes, while a full skin "roan" would require in the same solution about one hour. I call the solution weak if it contains 5 per cent. or less of the weight of the skins of bichromate of potash, and I call the solution strong if it contains more than 5 per cent. of bichromate of potash. The skins are done if small pieces cut from the thickest part thereof show that the solutions have entirely penetrated. The skins are then ready to be taken out of the solution, and, after the adhering liquor has run off, the skins are introduced into the second bath, which consists, by preference, of sulphite of soda dissolved in water, to which an acid—such as hydrochloric acid—should be added, in order to set free the sulphurous acid. The hydrochloric acid or its

substitute may be added to the bath in a free state or through the medium of skins previously pickled, such skins being impregnated with the proper acid. The solution may be strong or weak of sulphite, and the quantity of acid used may be increased if the skins show that more is required, which is indicated by the color of the skins. When the skins are done they show a whitish, bluish, or greenish color, according to the time they are kept in the sulphite bath. A skiver which first has been exposed to the action of the bichromate bath for fifteen minutes will be ready by remaining in the sulphite bath about twenty minutes. For thicker skins a proportionately longer time is required.

For some skins—such as calf or steer skins—it is desirable that the same, after having been withdrawn from the second or sulphite bath, shall be returned to the bichromate bath, which imparts to them a brownish color and leaves them in a favorable condition to be colored black. The leather coming from the sulphite bath is especially adapted for light and also for dark colors, and by proper dyeing methods better and brighter colors can be produced than on leather done by tannin. After the leather is done in the manner above described, it may be colored, soaped and greased in the usual way.

Leather can also be made by reversing the operation and first soaking the hides in a sulphite bath, and then exposing them to the action of the bichromate bath. By using the baths described at a heat of about 80° Fahrenheit, the process will be done in a shorter time than if the baths are used cold.

Tawed leather made by my process is very strong, soft and elastic, and my process is applicable to hides or skins of every description.

Instead of using sulphite of soda, I can use other sulphites or bisulphites in presence of an acid or an aqueous solution of sulphurous acid.

Concerning these patents, William M. Norris says:

1. Hides or skins are prepared for tanning in the usual way.

2. They are then subjected to the action of a solution of bichromate of potash in the presence of an acid.

3. The hides or skins are introduced into a second solution, which consists of hyposulphite of soda dissolved in water, to which an acid is added to liberate the sulphurous acid.

4. They are then finished in the usual way.

Some years ago Mr. Schultz sent a circular to the trade in which he gives further information, and enters more into details about his process, as follows:

Pickled roans or similar-treated skins, rinse in 70° F. warm water, or leave in water over night.

First Bath.—For every 100 pounds of skins, dissolve 4 pounds bichromate of potash in about six to eight times the quantity of boiling water, then add 2 pounds muriatic acid, stir well, and leave stand about half an hour, then add this liquor to the vat containing water sufficient to cover the skins, which must be suspended in it. The suspended skins should hang sufficiently far apart to allow the liquor an uniform penetration, which cannot be accomplished if the skins touch and press each other. Leave the skins in this liquor until the yellow color of the chrome has thoroughly penetrated, which can be perceived by cutting off a small piece from the thickest part of an average skin, and if the cut-off part shows an even yellow color, then the skins are done; take out; let drain, press out adhering liquor (perhaps a centrifugal machine will do it), and the skins are now ready for the second bath.

Second Bath.—For every 100 pounds skins dissolve in the vat containing the water in which the skins have to be suspended and sufficient to cover the skins, 10 pounds hyposulphite of soda; stir well until all is dissolved, then add 2½ pounds muriatic acid, stir again, and enter at once the skins which were done in the first bath, and keep the skins suspended in this liquor until the yellow color has disappeared and the skins have become whitish all through, which can be perceived by cutting off a small piece of the thickest part of the skin. Now take out, let drain, press out surplus liquor, and the skin has become leather and may now be finished in the ordinary way. I found it advantageous for suppleing the leather

to put in a solution of about 3 or 4 per cent. soap, leave it in several hours or over night, or rub a soft soap on both sides and let it lie sometime. Steer skins for sole leather, or any other leather which is suppled by grease, should receive such grease soon after coming from second bath and before the leather has commenced to dry.

The advantages of making leather by this process are: It is adapted to all kinds of hides or skins, furs or chamois. The leather by this process is much denser — tougher — therefore more durable than leather made in the ordinary way, by tan-bark, sumac, gambier, etc. The leather by this process can be boiled in water without impairing its quality; it remains leather, while all other leather made by tannin will be totally spoiled— destroyed by boiling. The thinner kinds, as sheep, will not shrink by boiling. The boiling test is a characteristic mark of this process. Because belts have sometimes to be exposed to heat, which is hurtful to tanned leather, beltings made from leather by this process promise more durability. The dyer is enabled to make brighter colors; on account of the color of this leather being whitish, it taking color with great ease. Sole leather now made at the depots of tanbark can be made by this process near any city. The freight to and from present tanneries is almost entirely saved. The saving of time and of interest on capital, is large, because the tanning of hides and skins by this process, as steer-skin for sole leather, takes only forty-eight to ninety-six hours according to thickness. Sheep-skin skivers may be done in about three hours, sheep-skin roans in three to six hours, sheep-skin fleshes, for chamois or gloves, in three hours. The materials used for this process are of low cost.

The bichromate, or first bath, if not exhausted, may remain for the next lot, only adding thereto a suitable quantity of bichromate and acid. For the hyposulphite bath it may appear well to use at first only half of the given quantities, and after the liquid becomes clear, and the sulphurous acid smell is faint, and the skin showing to need more, then more hypo-

sulphite and acid may be added by pouring this additional liquor in at one side of the vat without lifting the skins, only motioning the skins in vat. The preparing of the skins, as liming, sweating, unhairing, plumping, before they enter the tan liquors, must be done also for this process, and this process is distinguishable chiefly by the kind of liquor used against the ordinary tanbark process.

Before considering the chemistry of this process, the characteristics of the articles used, their properties and reactions upon one another, mention should be made of Mr. William Zahn, one of the pioneer manufacturers of chrome tanned leather in this country. Mr. Zahn secured a patent covering his process on June 28, 1888.

SPECIFICATION OF THE ZAHN PATENT.

My invention, says Mr. Zahn, relates to an improved process of tanning skins for making kid leather, and the process consists, first, in preparing the skins for tanning by treatment with sulphide of sodium or arsenic and unhairing the same, then treating it with dog manure and a solution of salt and water. After this preparatory treatment the skins are exposed to the action of three different solutions, the first solution consisting of bichromate of potassium, salt and muriatic acid; the second solution of hyposulphite of soda and sulphuric acid, and the third solution of a mixture of neat's foot oil saponified by caustic soda and extract of quercitron-bark, or other tannin-containing extract.

For preparing the skins and producing a strong and soft kid leather in a much shorter time than heretofore, the skins are first treated with sulphide of sodium for about three or four days—for seven to eight days when arsenic is used. The skins are then unhaired, scraped and placed in dog manure for some time. The skins are then cleaned of the dog manure and placed in a solution of five pounds of common salt and one hundred pounds of water, in which they are allowed to remain for about one-half hour. They are then removed and ex-

posed to the first bath, which consists, for every one hundred pounds of skins, of a solution of five pounds of bichromate of potassium, two pounds of salt, and two and one-half pounds of muriatic acid in five gallons of water. The skins are placed with this solution in a tub and rotated by stirrers in the same for about thirty minutes, so as to be thoroughly impregnated by the solution. The skins are then allowed to remain in the solution for about three hours, after which they are again rotated for about thirty minutes with the same. Thinner skins have to be exposed to the action of the solution for a less length of time than thicker skins, which have to remain for a greater length of time in the solution, so as to be thoroughly impregnated by the same. The skins are then transferred to the second bath, which consists, for every hundred pounds of skins, of eight pounds of hyposulphite of soda ($Na_2S_2O_3$) and one and one-half pounds of sulphuric acid of 6 deg. Baumé, dissolved in ten gallons of water. The skins are placed with the solution in the tub and agitated in the same for about half an hour. After an intermission of half an hour they are again agitated for half an hour, and then allowed to remain in the same from two to ten hours, according to the thickness of the skins. They are then washed and placed in the third bath, by which the leather is made soft and strong, and which consists, for every one hundred pounds of skins, of a mixture of saponified neat's-foot oil and two ounces of caustic soda, which are dissolved in one gallon of water and heated by steam until the neat's-foot oil is properly saponified. Then an extract of five pounds of quercitron bark in five gallons of water, or any other suitable solution containing tannic acid is added. The skins are placed with this solution in the so-called "pin-wheel," the last solution softening the skins and imparting the final tanning action to the same. The skins are exposed to the tannic acid solution for about half an hour, after which the leather is removed and dyed in the usual manner.

For light colors, the dye is given to the leather while it is in the pin-wheel, it being finally washed off and allowed to dry,

while for dyeing black it is best to remove the leather to the working bench and spread the color over the same. A coating of oil is then given to the leather on the grain side, after which it is dried at a temperature of from 70° to 80° Fahrenheit. If a gloss is to be imparted to the leather, a coating of some vegetable oil, preferably linseed oil, is finally given, which renders the leather water-proof, soft and durable.

By my improved method of tanning skins, the same can be changed into leather in from fourteen to sixteen days, the process producing kid leather of superior quality.

For the chrome bath Schultz directs for each 100 pounds of skins 4 pounds bichromate of potash, 2 pounds muriatic acid; and for the hypo bath for each 100 pounds of skins 10 pounds hyposulphite of soda and 2½ pounds muriatic acid; while Zahn prescribes for the chrome bath, for every 100 pounds of skins 5 pounds bichromate of potash, 2 pounds of salt, 2½ pounds muriatic acid; and for the hypo bath, for each 100 pounds of skins 8 pounds hyposulphite of soda and 1½ pounds sulphuric acid of 6° Baumé. The strength of the sulphuric acid mentioned is probably a mistake. No doubt 60° or 65° Baumé was what the inventor meant.

In order to express the composition of substances, and in representing the results of chemical action, more conveniently than can be done by writing the names of the elementary constituents at full length, chemists use a kind of short-hand, or symbolic language, which is very simple when once explained. Instead of writing the whole name, the first letter, or if the names of two or more elements begin with the same letter, the first two letters of the name are employed to designate the element; sometimes using the Latin or Greek name. Thus, instead of hydrogen, we write H; for oxygen, O; for nitrogen, N, etc. For carbon we write C; for chlorine, Cl; for chromium, Cr, etc. For iron we write Fe, from Latin ferrum; for copper, Cu, from cuprum; for potassium, K, from kalium; for sodium, Na, from natrium. These letters, however, signify more than this; they stand not only for the elements in ques-

tion, but they all have certain numbers belonging to them, which indicate the proportions by weight in which the several elements are found to combine with each other. Thus, H does not signify any weight of hydrogen, but always 1 part by weight. O signifies always 16 parts by weight of oxygen, because it has been found that the density or weight of a given volume of oxygen compared with that of the same volume of hydrogen is 16—hydrogen, as the lightest body known, being taken as the unit; so all the other elements have in the same way been compared with hydrogen and certain numbers given them, which is their weight. Cl (chlorine) is 35.5; K (potassium) is 39; Na (sodium) is 23; S (sulphur) is 32. Hence, it is evident that we may express by symbols not only the qualitative but also the quantitative composition of chemical substances. Thus, water consists of

Hydrogen	2×1 or H_2.
Oxygen	16 or O.

The symbol for water is, therefore, H_2O. The juxtaposition of the letters signifies that the elements are combined together in the proportions by weight indicated by the respective letters. The figure 2 placed below the letter H shows the combining weight of hydrogen (1) is to be taken twice. The sum of the combining weights, in this case 18, is the combining weight of the compound, water.

In preparing the chrome bath each of the inventors uses a certain quantity of bichromate of potash and one-half this quantity of muriatic acid. The reactions which occur here are $K_2Cr_2O_7$ (bichromate of potash) + 2HCl (muriatic acid) = Cr_2O_6 (chromic acid) + 2KCl (chloride of potash) + H_2O (water). That is, the muriatic acid breaks up the bichromate and forms chromic acid, chloride of potash and water. But why should one-half the quantity of acid be used?

To find the combining weight of bichromate of potash:

The weight of K is 39, that of K_2 is 78
The weight of Cr is 52.5, that of Cr_2 is 105
The weight of O is 16, that of O_7 is 112

$K_2Cr_2O_7$ (Bichromate of potash) is 295

The weight of H is..... 1
The weight of Cl is..... 35.5

HCl (muriatic acid) is 36.5

2HCl is 73, so when 295 parts of bichromate of potash are taken, 73 parts of muriatic acid are required, or when 1 pound of bichromate of potash is taken 0.248 pound muriatic acid is required—say ¼ of a pound. But this is on the supposition that the articles are of full strength and chemically pure, which is generally far from being the case. Muriatic acid is a colorless transparent gas; it dissolves in water very readily, and in this combination is known in the trade. The commercial article is a yellowish liquid, the color being due to the presence of impurities. A strong solution of the gas, which stands about 25 degrees Baumé, contains 40 per cent. of muriatic acid. The ordinary commercial article stands from 18 degrees to 20 degrees Baumé, and contains about 30 per cent. of muriatic acid. Now, granting that the bichromate of potash of trade is pure and of full strength, 1 pound would require about ¾ of a pound of muriatic acid to liberate all the chromic acid.

In the hypo bath Schultz takes 10 pounds hyposulphite of soda and 2¼ pounds muriatic acid, while Zahn uses 8 pounds hyposulphite of soda and 1½ pounds sulphuric acid. It is immaterial which acid is used, as the function of the acid is to break up the hyposulphite of soda and liberate the sulphurous acid, which is what is required to set the chromic acid in the skins.

The formula is, where muriatic acid is used:

$Na_2S_2O_3+5H_2O$ (hyposulphite of soda) $+2HCl$ (muriatic acid) $=SO_2$ (sulphurous acid) $+S$ (sulphur) $+2NaCl$ (chloride of sodium) $+H_2O$ (water).

Thus we have sulphurous acid, which is given off as a gas

with its peculiar, characteristic, pungent odor, sulphur which separates out as a yellowish white powder, chloride of sodium which remains in solution.

To determine the proper amount of acid to use in connection with the hypo:

The weight of Na is 23, that of Na_2 is 46
The weight of S is 32, that of S_2 is 64
The weight of O is 16, that of O_3 is 48
The weight of H_2O is 18, that of $5H_2O$ is..... 90

$Na_2S_2O_35H_2O$ (hyposulphite of soda) is 248

We have previously determined that the combining weight of muriatic acid is 36.5. So where 248 parts of hyposulphite of soda are taken, 73 parts of muriatic acid are required, or to 1 pound of hyposulphite of soda 0.3 pounds muriatic acid; but as muriatic acid is only 30 per cent. pure, 1 pound. So where 1 pound of bichromate of potash is taken, ¾ of a pound of muriatic acid should be used, and to each pound of hyposulphite of soda 1 pound muriatic acid.

In the same way we can determine the proper relation between the bichromate and the hypo:

Cr_2O_6 (chromic acid) + $3SO_2$ (sulphurous acid) + $3H_2O$ (water) = Cr_2O_3 (chromic oxide) + $3H_2SO_4$ (sulphuric acid).

The weight of Cr is 52.5, that of Cr_2 is.....105
The weight of O is 16, that of O_6 is 96

Cr_2O_6 (chromic acid) is.....201
The weight of S is 32..... 32
The weight of O is 16, that of O_2..... 32

SO_2 (sulphurous acid) is 64
$3SO_2$ (sulphurous acid) is 192

Therefore 201 parts of chromic acid require 192 parts sulphurous acid.

Now, glancing at first series of formulas it will be seen that 295 parts of bichromate are necessary to produce 201 parts chromic acid; and from second series formulas it will be seen that 248 parts of hyposulphite of soda are required to produce

64 parts sulphurous acid. But as 192 parts of sulphurous acid are necessary, it will require 744 of hyposulphite of soda. So when we take 295 parts of bichromate of potash we require 744 parts of hyposulphite of soda, or when 1 pound of bichromate is used, 2.53 pounds of hyposulphite of soda are required—say 2½ pounds.

In this manner we arrive at the theoretical quantities of the different ingredients used, but it has been found expedient to vary the relative quantities in practical use.

Both inventors first saturate the skins with chromic acid and then reduce this chromic acid to chromic oxide by means of sulphurous acid.

When a solution of bichromate is acted upon by muriatic acid, chromic acid and chloride of potash are formed. This chloride of potash, although it does not assist at all in the tanning process, at the same time exerts no injurious influence. Skins, when saturated with chromic acid, are in a most sensitive condition, and should be handled most carefully. The length of time they are exposed to the air, the state of the atmosphere, and particularly sunlight, all have a marked effect upon them.

When hyposulphite of soda is acted upon by muriatic acid, we have sulphurous acid, sulphur, chloride of sodium; and the sulphurous acid, when acting upon the skins, breaks up, forming sulphuric acid. So the stock is necessarily subjected to the action of all the above named articles, which certainly is not at all beneficial, quite the reverse.

Sulphurous acid itself is a difficult reducing agent to properly control. It adheres most tenaciously to the skins, and efforts made to remove it are not always successful. To this are due many of the troubles which beset the manufacturer who undertakes to work this process, because when leather is finished without having previously thoroughly removed every trace of sulphurous acid, it will harden, crack, show grease spots, and be in every way most unsatisfactory. In fact, to proceed to manufacture leather according to the directions

which these inventors give us, would result in a not very satisfactory or salable product. After the skins have been tanned in the liquors above described, they should be washed in warm water, then in ¾ to 1 per cent. borax solution, and finally in water. All chrome goods must be fat liquored (see Chapter XV.) and dyed before they become dry, or soaked in some kind of a solution to prevent complete drying out, as one containing 5 per cent. salt and 5 per cent. glucose.

PUTTING-OUT MACHINE.

The work of "putting out" goat and sheep-skins in the process of manufacturing Morocco leather was commonly done by hand; but machines have been invented for this purpose that are steadily coming into use.

The object is to press out the water and tanning liquor, and to scrape off the small pieces of flesh or other imperfections that adhere to the flesh side of the skin, and to render the grain side smooth and otherwise to improve its appearance.

Fig. 96 shows a perspective view of Vaughn's machine for "putting out" and also striking out goat, sheep, calf and kangaroo skins. It is built by the Vaughn Machine Co., Peabody, Mass.

This machine is so well and extensively known and used throughout this country and Europe that a description is hardly necessary. It is the only machine that will do the work, and its excellence is proved by the fact that it now has nearly supplanted all hand work in this branch of the business. Its construction consisting of two parallel cylinders, revolving in opposite directions, and a vertical table on which the skin is placed passing up through them, is sufficient to convince anybody that it cannot help doing the work much better than it can be done by hand, as the whole skin is worked at once and from the back to the belly, taking out all bag and stretch thoroughly, leaving the skin fine, dry, even, smooth, and in perfect shape; in fact, perfectly put out in every particular.

The manufacturers guarantee that this machine will put out,

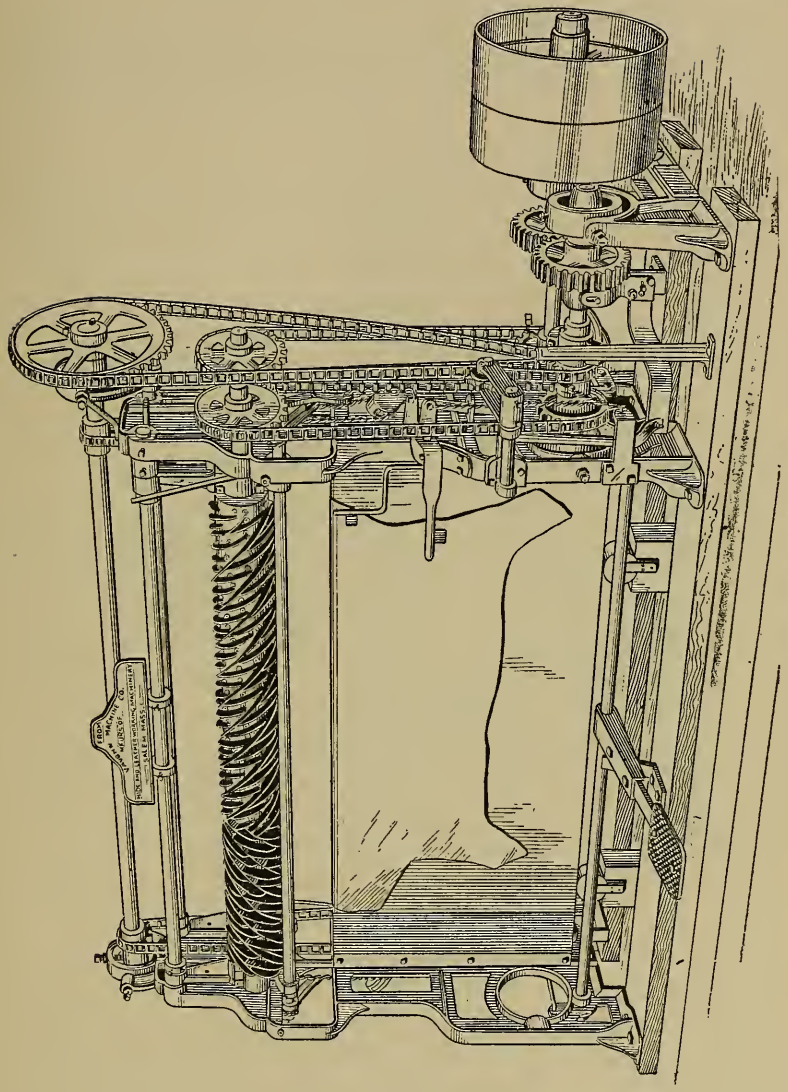


FIG. 96. A PUTTING-OUT MACHINE.

both first and second way, all kinds of chrome-tanned stock, Russia calf and all fancy-colored skins, India tanned goat and sheep-skins in any finish, sheep-skins either bark, sumac, or Dongola tanned, glazed, mat or dull kids of any tannage, kan-

garoo skins, and in fact anything that is now made by manufacturers of morocco and light leathers of all kinds; that it will entirely take the place of all hand work for this purpose in the factory.

The same machine will either strike out or put out, or both.

They claim a decided gain in measurement over hand work, besides the great saving of labor. Very little space or power is required to operate it. Each machine is fitted specially with the proper cylinders for doing any particular kind of work required, and guaranteed to give perfect satisfaction. The machine is very efficient, and it leaves the skins dry, even smooth, and in a most desirable condition.

Necks, butts, and shanks are also put out by it in a better manner than it is possible to perform the work by hand.

Under the present system of chrome tannage every step of the finishing process is accomplished by a different person, each man having his own specialty. A seasoning mixture is applied to the surface after tanning and before coloring.

Fig. 97 shows a form of seasoning machine which is largely used for all kinds of glazed kid. It is the invention of Shute and Faulkner, Lynn, Mass., practical morocco manufacturers, doing a large glazed kid business and whose seasoning is done wholly with this machine, as is also that of nearly all the other Lynn manufacturers, who will attest to the efficiency and practicability of this machine for the above named work.

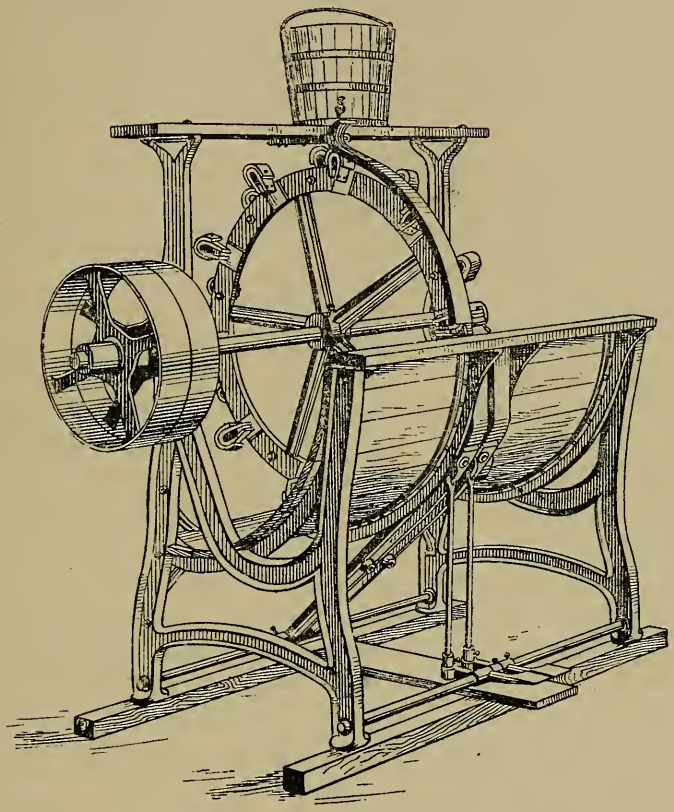
The machine is built by the Vaughn Machine Co., Peabody, Mass.

In construction it consists of a wheel, carrying two sets of flexible pads, arranged on opposite sides of the wheel, beneath the wheel two circular forms attached to levers, treadle rods and treadles to raise and lower them, each form to serve as a bed for the set of pads which pass directly over it, and a metallic apron or spreader above the wheel to distribute the seasoning evenly on one set of pads, together with the table to support the skin, and shelf to hold the seasoning tank.

The mode of operating the machine is, to pass a skin under

the wheel, between the pads and circular bed, to start the seasoning running, usually from a slow to a very fast drop is sufficient, according to the quantity of seasoning required to be spread on the skin. By placing the foot on the treadle it

FIG. 97.



SEASONING MACHINE. (FAULKNER PATENTS.)

brings the skin up to and in contact with the revolving pads, then by drawing the skin from the left to the right, the left hand or spreading set of pads passing over the skin first spreads the seasoning, and the right hand set, which remains comparatively dry, following after the wet ones, rubs the seasoning thoroughly into the skin.

The quantity of work that a machine will do depends so much on the condition of the skins and the seasoning, that no definite numbers can be given, but it has been found in almost every instance to do from two to three times as many as can be done by hand. The quality of work is always as good, and in many cases better than previously done by hand, owing to the immense amount of rubbing that the machine does, which can be better understood by a comparison of the number of strokes it makes on the skin, with the number made by hand in the same time.

Allowing a man to make a stroke a second, which would be very fast work, the machine carrying twenty pads runs at eighty revolutions, making 1,600 strokes per minute against 60 strokes by hand.

The machine can be easily adjusted to the pressure required, also to make it season heavy either on the sides or middle of the skin.

Owing to its simplicity of operation, and good results in both quality and quantity of work done, it is fast being adopted by all leading manufacturers of the country, and cannot help being universally used by all manufacturers of glazed kid in the near future.

For seasoning use ¾ blood, ¼ flaxseed water strained, and a few drops of sulphuric acid; this makes a splendid strong seasoning. In some factories they use 1 pint of milk and 1 pint of water.

The skins are then thrown into the coloring drum and thrashed about in the coloring liquid for an hour. The plaiter next takes it in hand, folds it down the back, face out, and runs lightly over it with a tool known as a "slicker," causing the inner sides to closely adhere. Then he rubs in a scour with a hard brush, and the skin is turned over to the boxman. This latter dips it into a box filled with a black liquid, and turns and shifts it for some fifteen minutes. Then it is run through a "striking-out" machine shown in Fig. 96, which removes all superfluous moisture. The skins are then packed in saw dust,

staked and shaved down on the emery wheel and then the skin is glazed by machines, seasoned a second time with milk and water and reglazed, after which it is hung in a steam-heated room to dry, and this, save for light oiling, completes the process.

In Figs. 98 to 105 we show the plans of the kid factory of F. Blumenthal & Co., Wilmington, Del. This is one of the largest establishments of its kind in the United States using the chrome process and is at the present time being greatly enlarged.

FIG. 98.

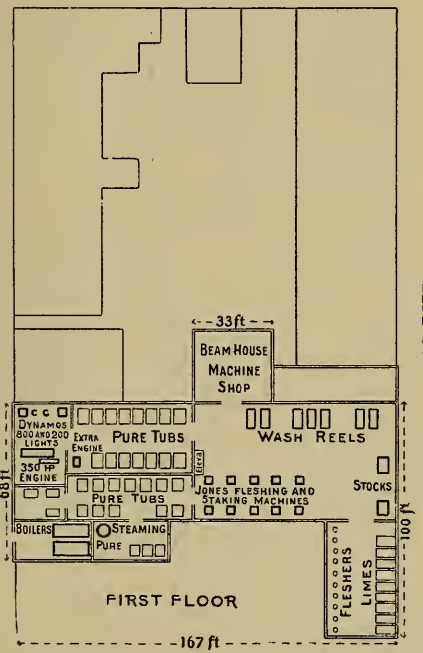
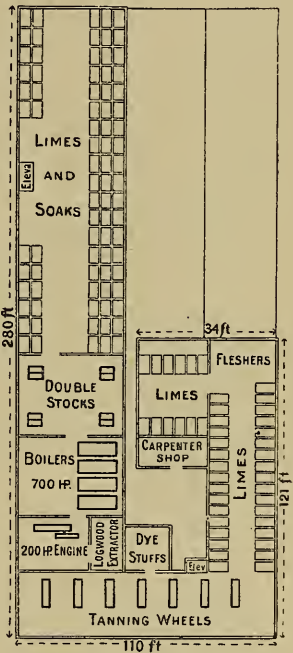


FIG. 99.

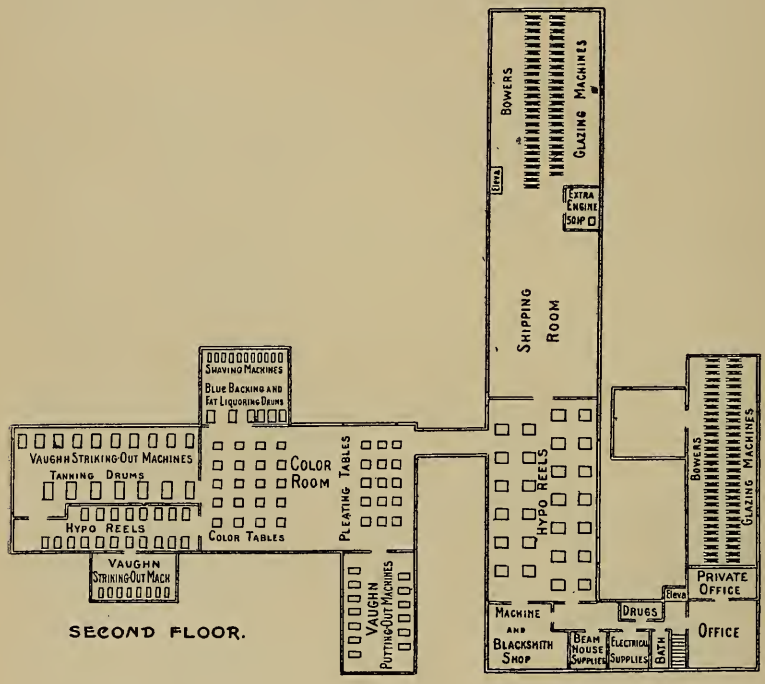


The plans show the number of machines in each room, but do not show the fifth and sixth floors, which are mainly devoted to steam drying. There are, however, above the perching room on the fourth floor, two large logwood tanks, and in

the opposite wing, above the general storeroom, a sawdust room.

The capacity of the plant is 1,500 dozens of skins daily. The machinery is of the latest and best. There are 33 Vaughn machines, 186 Bowers glazing machines, 70 Hysore glazers, 20 color boxes, 12 pleating tables, 6 blue backing and fat liquoring drums, 14 tanning drums, 44 hypo. reels, 28 Weber

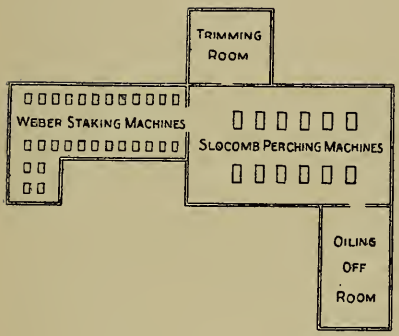
FIG. 100. FIG. 101.



stakers, 50 knee stakers and 12 Slocomb perching machines. These perching machines take the place of hand work, as they are far more efficient and speedy. About 1,000 hands are usually employed; 200 girls do the seasoning, glazing and measuring. The product is glazed kid, black and in colors.

This firm was among the first to adopt the chrome process. They bought the Schultz patent, and sold it to the Patent Tan-

FIG. 102.



THIRD FLOOR.

FIG. 103.

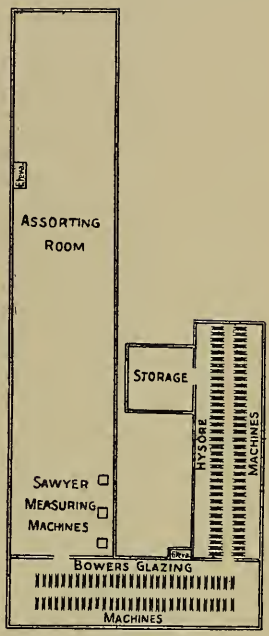
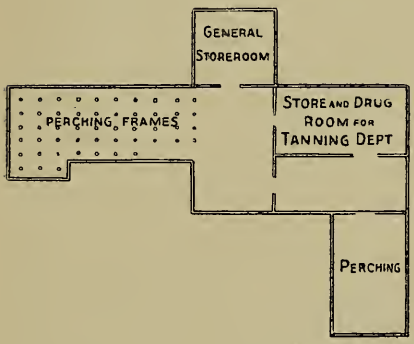


FIG. 104.



FOURTH FLOOR.

FIG. 105.

nage Company, of Philadelphia, Pa., reserving to themselves the right to use it. They import all the skins they tan, and have the advantage of a close European selection.

INDIA TANNED GOAT.

The finishing of India tanned goat skins is an important branch of manufacture in Peabody, Mass., and in some other parts of the country.

In good times several thousand dozens of these skins are finished in Peabody every week. The amount of goatskins imported from India greatly outnumbers that of the sheep, and they fill a place in the manufacture of shoes entirely distinct and independent. All the Morocco leather that is produced in the United States from skins in the hair is made by the chrome or oxide process, which renders it soft, springy and elastic, and entirely unfit for pebble grain work. Here is where the India goat comes in. Being tanned in the slow, natural way, it has a firmness and body entirely suitable for graining and pebbling. It also makes a cheap kid a pretty fair color, and a dull Dongola for men's shoes. All these skins undergo cleansing and retanning processes, and while furnishing leather for ordinary grades of shoes, do not conflict with the chrome leather, except on a few lines.

There is some Morocco leather still produced in the United States by the old method of sumac tanning.

SUMAC TANNED SKINS.

If the skins have been tanned with sumac they are next "struck out" on mahogany tables, which are so shaped as to slant from the workman at an angle of about 45°.

A steel "slicker" is used for this operation, and an average workman will "strike out" about 200 skins in ten hours.

The object of this operation is to increase the size of the skins, remove the adhering "fleshings," tanning liquors, and water, and render the skins smooth and even, and this is accomplished in many tanneries by the employment of machinery.

The skins after being "struck out" are hung up in the drying lofts and dried by the atmosphere; the time required for this depending upon the condition of the weather.

Fig. 106 shows the drying loft in a Morocco factory, the skins

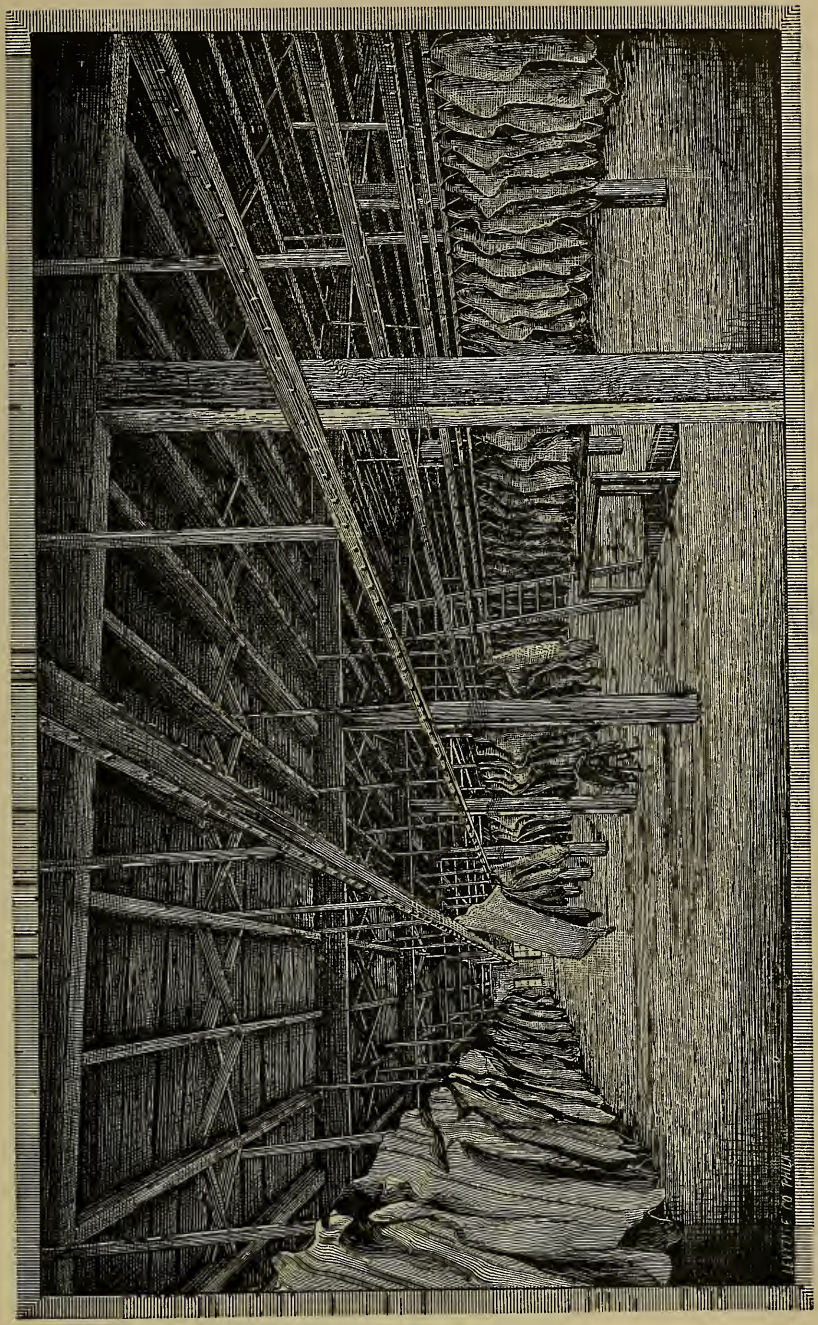


FIG. 106.

DRYING-LOFT IN A MOROCCO FACTORY.

being hung on hooks which are shown on the racks placed at a convenient height from the floor. When sufficiently dry the skins are removed from the hooks and carried to a room on the same floor as the loft, and there assorted according to the kind of leather into which they are to be finished. This important point having been decided upon, the skins are removed to the cellar and wetted down in soap-water, and while wet the skins are carried to a currier's beam and shaved with a currier's knife on the flesh side, so as to make them of a uniform thickness, and also for the purpose of having them receive a better finish.

From this point all the skins pass to the finishing-room, and as each kind of Morocco leather requires a different treatment, we will now describe each separate mode of finishing the various kinds.

FINISHING IMITATION OF FRENCH KID.

This class of leather has taken a high rank in our country, and it is now generally conceded to be much superior to the genuine French kid for wear.

The skins, after being treated as above described, are carried to the coloring table and colored on the grain side, with an iron and nutgall-black having a logwood body, which gives a clear and bright black, and after being blacked the skins are hung up in the loft. The skins, after the first blacking has dried, next pass into the finishing-room, and the second application of black is made, which is similar to the first, with the exception of the nutgalls, which are omitted; bichromate of potash is sometimes used in this black, but in small quantities. After this second application of color, the skins are hung upon racks in the finishing-room, and left until the color sets or dries, the blackened side being turned inward, as shown in Fig. 107, which shows a perspective view of the blacking tables and an interior perspective view of the finishing-room.

After being removed from the hooks they are next moistened with a solution of milk and water, and are then ready to be

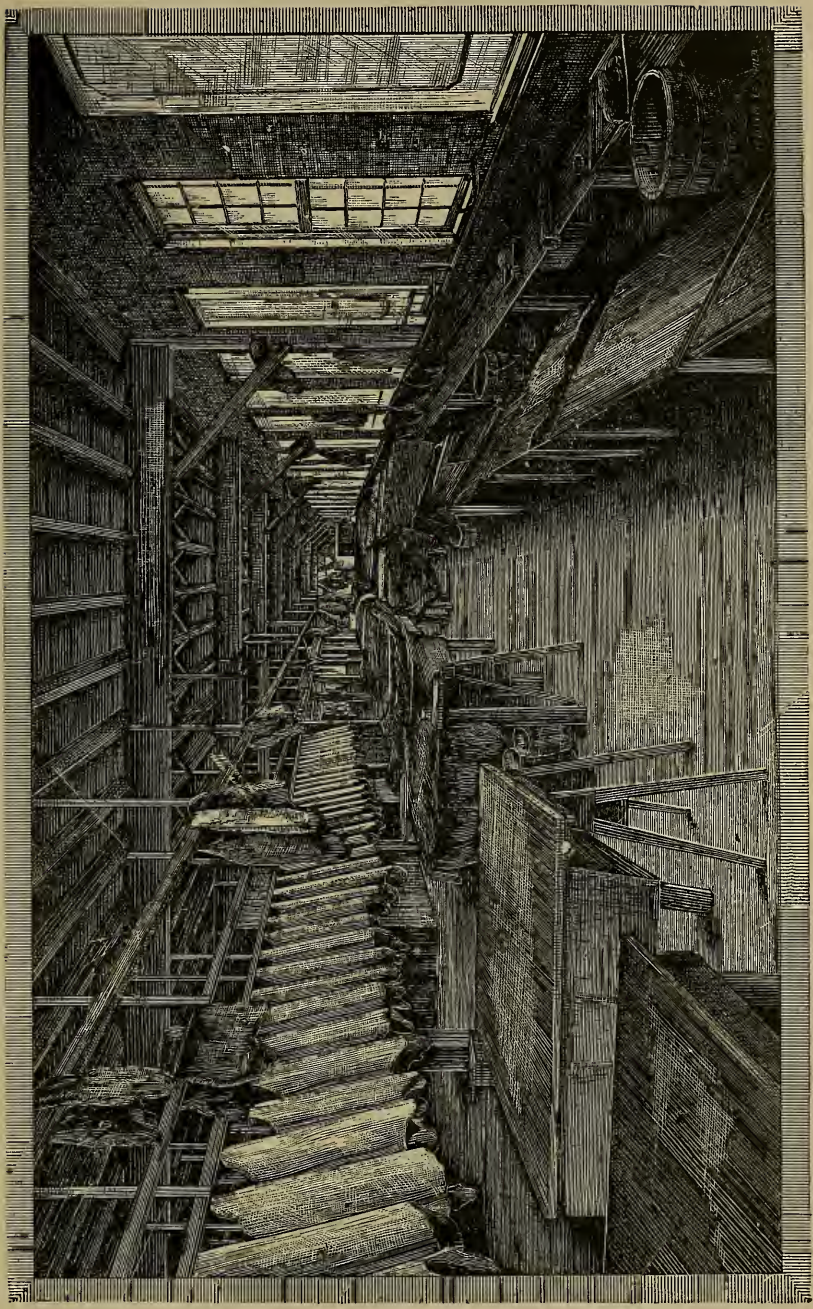


FIG. 107. FINISHING-ROOM IN A MOROCCO FACTORY.

glazed, which operation is performed by machines of various constructions, and which have been heretofore explained in Chapter XIX.

The skins are next softened by hand with a board and scraper, or, as it is termed, a "softening slicker."

They are then oiled with the best sperm oil, which is applied with a rolled-up flannel cloth.

The skins are glazed two or three times as the case requires, the oil is applied twice, and after the last application the imitation French kid is ready for market.

In selecting skins for the production of this class of leather, their weight is regulated by the demands of the trade, at times being light, and at others heavy. The skins are also selected for their cutting qualities, those which are free from blemishes or breaks being, of course, more valuable than those that are scratched.

FINISHING BRUSHED KID.

The finishers take the South American goat-skins from the shaving-beams and "put them out," and each man will put out and black five dozen per day, and after being thus treated they are hung in the loft and dried by the atmosphere.

The skins are blacked and seasoned with the same preparation of bullock's blood, iron, and vinegar black, which is applied with a piece of flannel cloth made into a roll. They are then wet over with gum-water and brushed with a very soft brush, called a "kid-brush." After being hung in the loft and dried, the skins are next "back-boarded," then glassed, and next rolled by a machine having a steel roller.

The finisher takes the skins from the rolling machine and scrapes them with a steel slicker in order to loosen up the flesh, after which the grain side is oiled with the best sperm oil, which is applied by means of a roll of flannel cloth. The brushed kid is now completed and ready for market.

FINISHING STRAIGHT-GRAINED GOAT.

The first step after shaving in finishing this variety of

Morocco is the "putting-out," which is performed by working over both sides of the skin with a steel slicker. This portion of the work is usually accomplished by machinery. When done by hand about five dozen large skins or nine dozen small ones are put out by a skillful workman in one day. The skins thus treated in the morning are placed in the loft, and in the afternoon they are "put out the second way," which consists in smoothing the grain side. They are drawn out and the stretch removed in the first operation.

When the skins are placed in the loft they are spread out separately on the floor, as shown in Fig. 108, and are not allowed to become too dry, and in the afternoon when they are "set out the second time," no water issues from them. After being set out the second time they are returned to the loft and placed on trestles, which are about two feet six inches high, and they remain in this loft until dry, the period of course depending upon the state of the weather.

The day's work of each man is kept separate from that of the others, and each workman hangs up his own day's work of skins, one on each hook, and so placed that none of them touch each other.

When dry the skins are packed in piles, those that are intended to be stained on the flesh side being separated from those that are to be pebbled.

They are next carried to the finishing-room and the rough part of the grained side is smoothed off with a piece of fine emery paper, rolled so as to expose the length of the paper to the skin.

This portion of the work is sometimes accomplished by machinery; a revolving emery stone, such as is used in the manufacture of kid gloves, being employed, the dust being blown from the stone by a suitable fan.

The skins are next seasoned, which is accomplished by coating them with a preparation of bullock's blood, logwood boiled, cow's milk, water, and a small quantity of vinegar black, made by treating iron with vinegar, one gill of the latter preparation

FIG. 108.

VIEW OF DRYING-LOFT IN A MOROCCO FACTORY—SHOWING THE SKINS SPREAD OUT.

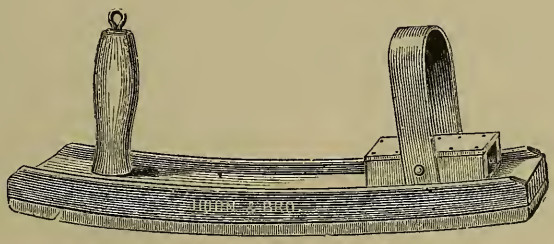
being used for a bucketful of "seasoning," which quantity will season above five dozen straight-grained goat-skins. After the seasoning has dried they are regularly blacked and hung up in the finishing-room, as shown in Fig. 100, and after remaining on the hooks for about one and one-half-hours, or until the dampness leaves the skins, they are rolled by machinery. After being rolled the skins are again hung up in the finishing-room and remain over night, and in the morning they are glazed on a machine having a glass roller. Fig. 109 shows a rolling and glazing-room in a morocco factory.

The number of skins rolled or glazed is from 30 to 50 dozen per day for each machine, depending upon the speed at which the machine is driven, and also upon the size of the skins and quality of the work. Some are glazed lighter than others, in order to give a medium gloss, but when a high gloss is desired, extra pressure is applied.

After the skins are glazed they are wetted in cold water by passing them through a large tub holding about 50 gallons, and the workman in accomplishing this takes two of them and places them grain to grain, and grasping hold of the butt of the skins draws them slowly towards him.

They are next grained, which may be performed either by hand or machinery; if done by hand, a graining board similar to that shown in Fig. 110 is employed.

Fig. 109.



These graining boards are made with a cork face, and in using them the arm passes through the strap and the hands grasp the handle.

FIG. 110. ROLLING AND GLAZING MOROCCO.

The object in using this tool is to raise the grain and to make the straight-grained goat-skins more durable, and also has the effect of rendering them more pliable as well as tougher.

The skins are again hung in the loft, usually above the finishing-room, and dried by the atmosphere, which requires from 24 to 48 hours, according to the state of the weather. After this drying they are again grained, which has the tendency to raise the figure and further mellow them. All the graining is done on the grain side; but after the second graining they are "back-boarded" on the flesh side, which has a tendency to make the figure more uniform as well as to still further soften the skins.

An application of best sperm oil to the grain side of the skins completes the finishing of straight-grained goat, and as the oil is immediately absorbed by the pores, the skins are at once ready for market.

From the time that they enter the finishing shop to the time that the straight-grained goat is ready for market, the period is about seven to ten days, being shortest in good drying weather and longest when the condition of the atmosphere is not favorable. There is also a grade of Morocco leather known as "caracal," which is straight-grained calf, and its peculiarities are pliability, toughness, gloss, and superior finish. This leather has a fancy finish, and its introduction into the trade has been but to a limited extent.

FINISHING PEBBLE-GRAIN GOAT.

The difference in finishing pebble-grain goat fromstraight-grained is that the first named is "cut" four ways in the process of hand-finishing, in the softening, and in the "springing up;" but in "back-boarding" it is cut two ways only. The skins are pebbled on the same machine, but not with the same roller that is used for straight graining.

FINISHING OIL GOAT.

In finishing "oil goat," after the skins have been "put out

the second way" and blacked, they are then stuffed with dubbing on the flesh side. The dubbing is composed of one-half oil and one-half tallow when used during the winter time; but in the summer more tallow than oil is used. They are then hung up to dry, after which they are grained three ways and then treated to a coat of dubbing on the grain side, after which they are flattened down on the grain side with a dull slicker, and after being treated with a coat of fine sperm oil which completes the finishing, the oil goat-skins are then measured and marked ready for the trade.

This class of Morocco leather is more water-proof than the other grades of sumac-tanned skins, and is used in a small way for ladies' heavy wear, and sometimes boys' boots are made from it.

The heaviest skins are used for this kind of leather, and the kinds commonly employed are Tampico, Capes, and Patnas.

COLORING.

William M. Norris, of Princeton, N. J., gives the following information about coloring:

"At the present time, when the greatest economies are essential, it would doubtless occur to some manufacturers of glazed kid that a saving might be effected if they themselves made their own "Black," "Sig," "Seasoning," "Stains," &c. Even if successful in producing good articles, which is very doubtful, the saving is infinitesimal and the economy a most costly one. Take "Black" for example; a barrel of "Norris Black" will color about 600 dozen skins and costs about $7.50. Say these skins measure 50 feet to the dozen, we will then have 30,000 feet of skins, and the black therefor will cost $\frac{1}{40}$ of a cent a foot. Provided the black made by the leather manufacturer himself costs nothing, the saving is hardly visible; the difference in color will, however, be quite apparent.

"It is in fact, determined by long experience, that in all manufacturing operations the fewer the articles made, and the more attention is concentrated on these few, the greater perfection

will be attained. A specialist in the manufacture of coloring materials for leather who thoroughly understands the properties and relations of the raw materials employed, and the best methods of combining them, will produce far better and more economical products than the individual leather manufacturer."

Mr. Norris makes a black which is a great favorite for chrome tanned leather.

DONGOLA CALF.

Make packs of convenient number according to size of soaks and limes, 200 or 250 skins of 9 to 12 lbs. or 7 to 9 lbs. or more of small stock. Soak thoroughly and break well, either by hand or machine. Trim and re-soak if necessary, before going to limes. As red arsenic has a very softening effect in liming skins it is generally used on this class of work in connection with lime. Make up limes in proportion of 85 parts lime and 15 parts arsenic to 400 to 500 gallons water.

The first lime should be weak or four per cent. Stock should be hauled daily and strengthened a little, keeping the above proportion of lime and arsenic. Lime eight or ten days. When hair slips freely, unhair by machine or hand, carefully. Wash in hide mill or paddle vat until stock is fairly clean of lime. Flesh on machine ; fine-hair grain on beam and shave heads down some. Wash again and then bate fairly low. Some tanners use solid bate for this work ; others, a liquid bate. Any of the known bates are good.

After bating, work well on flesh, and slate the grain. Then rinse and bran-drench in mill for 45 minutes. After which, drain and put in tan. Make up liquor in same way as for goat tannage, holding calf in tan 48 hours longer than on goat. After eight days in tan, haul and drain well over night and oil in mill. To every 150 skins use four gallons (half cod and half neatsfoot oil). Run one hour in oil, then remove from mill and put in loft to dry.

When dry, pack down five or six days, then wet back in mill to shave, using tan liquor to dampen stock, and don't get it too

wet. After shaving, re-tan in mill four or five hours, in four or five per cent. strength of liquor. Then put on hooks to dry. When dry, wet down in mill to color.

To every five dozen skins use three pails water and six gallons fat liquor. If a good yellow flesh is desired, dissolve four ounces auramine in boiling water and add it to fat liquor. Run stock 45 minutes in fat liquor, after which color and strike out on grain and oil off with half cod and half neatsfoot oil.

After oiling put in hot room to dry. When dry lay in dust to dampen for staking. Stake well on machine, flesh up. Air off and pad grain, then put in perch and arm-stake flesh and slate grain. Iron and trim, and measure. Then oil off, and pack down in oil over night black to black. The next day wipe off grain with flannel, and stock is finished, and may be sorted and dozened to ship away.

THE OLD PROCESSES OF CONVERTING GOAT-SKINS INTO "DONGOLA" AND OTHER FINE LEATHERS.

It is the purport of this section to treat, not of the more modern tannages, but of the earlier brands that were for a number of years, and very justly, regarded as standard—we refer to the "Dongola" and preceding tannages.

The different processes through which goat-skins pass in their conversion into Dongola are: Soaking, milling, liming, unhairing, fleshing, washing, bating, slating, bran drenching, tanning, striking out, drying, assorting for finishing, wetting, shaving, dyeing, glazing and assorting for weight and grade.

The skins come to the factories in bales—the bales containing from 100 to 600 skins each—and are placed in the storage room. They are then in a dry state. The first treatment to which they are subjected is that of "soaking," which consists of placing the skins in vats filled with cold, clear water. Here they remain for from 24 to 48 hours, according to the weight or texture of the skins. Those possessing a hard fibre will require a longer time to become thoroughly softened than those of a softer texture.

When thoroughly soaked they are taken out and placed in the "mill." This is a contrivance which consists of one or two large stones revolving vertically on a wooden pit. The stones are usually immense granite rollers, about four feet in diameter and from eight to ten inches thick. The pit around which the perpendicular stone revolves is about two feet deep. After "milling" they are washed until they are thoroughly soft and pliable—in fact, in much the same condition as when they are taken off the backs of the animals. The skins while milling are placed under the roller by a workman, who occasionally turns them from side to side, and brings them effectually under the operations of the revolving granite block. Of course there are other means of reducing skins to the proper state now in use.

The next process is that of "liming." The skins are permitted to remain in the limes usually from twelve to fifteen days, according, as in the case of other processes, to the texture of the skins. The object of the "liming" is to thoroughly loosen the hair on the skin, so that it may be afterwards rapidly and completely removed.

We now follow the skins to the unhairing room, where they are placed on unhairing beams and depilated and fleshed by workmen who use for the process long, rounded knives peculiarly shaped for the purpoe. All the processes through which the skins have up to this stage passed prepare them, by softening, removing all impediments and opening the pores, to permit the ready entrance of the tanning ingredients. The skilled tanner will be ever on the alert in his intelligent watchfulness through all these preparatory stages, and will exercise his discretion as to duration of time, etc., according to the heft of the raw stock, the temperature of the weather and the condition of the water.

From the unhairing room the skins pass to the "wash-mill," where they receive a thorough washing, removing all adhering lime, and preparing them for subsequent treatment.

The next process to which they are treated is "bating." The bate is usually composed of dog munure, dissolved in

slightly heated water. This process is now usually designated "puring." The skins are left in the bate for about ten hours.

They are now ready, on removal from the bate, for the slating room. Here is completed whatever may remain unfinished in the unhairing room by removing every particle of hair that may still adhere to the skin. The tool used in this process is called a "slater," which in a large degree resembles a "slicker."

The skins are next subjected to the bran-drench. The drench is composed of bran and water. It is slightly heated.

In the old sumach tannage the skins were next sewed in bags and filled with sumach liquor, grain side out. They were piled up in a heap in a vat filled also with sumach liquor. In the course of one day these skins were filled and emptied five different times, in order that they might be thoroughly and evenly tanned. After this they were transferred to the "striking out" room. The "striking out" was performed on mahogany tables, slanting downward from the operator at an angle of about 45 degrees. For this purpose the "slicker," referred to in a preceding operation, was used. In this process the size of the skin is somewhat enlarged, and any adhering "fleshing," tannin or water, completely removed. The skins during this operation became smooth and even, and the work of beautification—if the term be allowable—commenced.

After being "struck out" the skins were dyed or "blacked," usually on a table, the present method of dyeing, of course, not being used.

We next find the skins in the "drying room," where they were suspended from hooks in a row along the ceiling. The time used for drying was regulated largely by the condition of the weather.

When dry they were assorted for particular finishes, each skin being set apart for the finish to which it was best suited. After being finished they were again assorted for quality and weight, when they were ready for the inspection of buyers.

Thus it will be seen how very varied and critical were the processes through which a goat-skin had to pass during its conversion.

CHAPTER XXIV.

OAK TANNED SOLE LEATHER—UNSCOURED AND SCOURED LEATHER—CUT SOLES.

THE hides used are the packer hides from the packing houses in Chicago, Kansas City, Sioux City, St. Louis, Omaha, Los Angeles and other points. Country hides and South American hides are also employed.

Texas hides are usually branded and are made mostly into unscoured. Those which are unbranded and those having only a few brands not very marked are used for scoured leather.

South American hides make a very clear grain scoured leather, which is used by manufacturers of best men's shoes.

The hides are placed in the "soaks," in which they remain about three days, the period depending upon their condition and upon the temperature of the water in the "soaks." Warm water requires proportionately less time than cold water. Some tanners claim that warm water will soak hides more efficiently, and that the filth etc., can be better removed, or the hide better cleansed for the "limes," which is very important. It is said that the loss of "hide substance" is also less, because less time is required for soaking.

The water in the "soaks" is changed with each pack of hides. To-day, careful tanners withdraw the packs after the first day's soaking, run off the dirty water, and replenish with fresh. The day of putrid soaks is past. Tanners are saving money by keeping their soaks clean and not leaving the hides in rotten water. It is a small point, but worth remembering.

The hides may be fleshed at this stage—called "green fleshing," or they go into the "limes" and remain for about

five days or more and are then unhaired and fleshed, as desired.

While in the "limes" the hides are changed each day by means of a power reel into stronger lime, and when the hair is loosened they are unhaired and afterwards fleshed, and then thrown into a vat of clear water and left to remain over night.

In the morning the hides are removed from the clear water and "grained," which process consists in scraping the hides on the grain side in order to cleanse them more thoroughly from the lime remaining in the pores.

After being "grained" the hides are again placed in clear water, where they remain for three or four hours, which completes the beam-house work.

In some tanneries the unhairing and fleshing is done entirely by machinery; the tanners claiming that the cost of the beam house work is only about one third as much when done in this way compared to hand labor. Unhairing and fleshing machines are shown in Chapter VIII.

The hides after being unhaired and fleshed by machinery are usually bated over night in a bate made by adding about one gallon of molasses, or more, to the vat of water.

Some tanners still flesh and unhair by hand, because the machines they tried years ago for these purposes were crude and unsatisfactory. Some tanners forget that the modern machines are successful, and decidedly economical to use. Small tanners may not do enough business to encourage their buying beam-house machinery; but, no matter how large or small their place may be, before abandoning all hope of using machines let the tanner ask the advice of clever and courteous machinery men, who may be able to give some valuable information. Some tanners can unhair by machine all right, but find it better to flesh by hand, as they get better sole-leather in this way.

The sole-leather tanners that we know do not leave the hides in lime for more than two or three days. But during this time they are handled several times, and the limes kept plunged up. The scheme of giving limed hides a warm bath, say 100 to 110

degrees, during the night previous to unhairing, seems to work pretty well. The hair, after the hides have been pushed somewhat quickly through the limes and warm water, may come off hard on the beam, but this is safer for the tanner than when the lime has so dissolved the hide matter after prolonged liming that the hair slips off almost by itself. This is all very nice for the beamsters, particularly when they are on piece work; but we would prefer giving the men a fair day's pay, so that, even if the hair comes off hard and slow, they would not be justified in complaining.

Some tanners are too economical in working the grain, after they unhair. Whether machines or hand are used, clean, bright leather cannot be obtained unless the grain is carefully and thoroughly scudded. There are establishments where hides for sole leather are put through a mild bate before being fine-haired and worked on the grain. It is claimed that the bating by its assistance in expelling lime from the fibre tends to make softer and smoother leather.

Union leather is liable to be cloudy and dirty on the grain on account of careless beam-work. Bad salt is also an enemy of clean grain. Hide dealers as a rule are willing to accommodate their customers, and it is generally agreed by well-posted men that hides cured by Syracuse coarse salt are not so liable to have dirty grain as when fine salt or harsh mined salt is used. Tanners should ask their hide men to use only the best, cleanest and mildest salt. Salt-stained leather is a nuisance and an expensive eye-sore, and might be avoided if the proper salt were used in curing. Borax is the best agent for preserving hides. One pound of borax will go as far as five pounds of salt. When borax is used, there are no stains of any kind.

When sweats are employed it is often good policy to give the man in charge of them extra wages of a dollar or two each week. This small premium will be a great inducement to him to attend zealously to his work. There will be times at dead of night when he will have to enter the pits and unhook the hides, so as to stop the decomposition. In putting sweated

hides through the hide-mill, there should be no hurry. While there is no need to move the tender stock about too much, the work should be well done. In this connection we would urge that after soaking dry hides they ought to be specially well milled, so as to prevent any hard spots remaining.

It should be the duty of every tanner to keep a ledger account of each lot of hides put through the tannery. He ought to isolate each important lot of hides received from each dealer. These should be marked with a letter or number and carefully followed through the tannery right to the weighing-out scale in the leather lofts. It could then be easily discovered which dealer it was more profitable to buy from. These suggestions may cause careful tanners to smile, but they would be surprised if they knew how many tanners there are who take chances on what they are doing, trusting to luck to come out all right.

The hides are next suspended in "rockers," which operation is the first stage of the tanning proces, its object being the removal of the lime still remaining in the grain, the swelling of the hide and setting of the color. The hides are rocked from two to three times per day. They remain in the "rockers" from seven to ten days, depending upon the number of "rockers" and hides worked per day.

The hides are now taken out of the "rockers" and rehung on sticks in the "handlers," where they remain for ten to fourteen days, depending, as before, upon the number of vats and hides worked per day.

In some tanneries the hides remain undisturbed on the sticks in the same liquor for the required period; while in others the liquor is changed regularly. Again, in some tanneries the hides are handled from one vat into another, that is, the hides are moved forward to meet the stronger liquor.

It should be noted that the quality of leather is made in the "rockers" and "handlers," that is, the color, plumpness, etc.

The liquors supplied to the "rockers" must be mellow and not strong. The strength of the liquors must be regulated by the number of pits used, so that the green hides should have

sufficient acid in the pit to purge it of lime and properly start the plumping.

The liquor going on the hides in the "handlers" is considerably stronger, judgment being used as to the strength, which is governed by the extent to which the tanning has progressed in the "rockers."

After having been in the "handlers" the required time, the hides are placed upon a truck and conveyed to the yard proper, or "lay-away" yard, where the tanning process is completed. The "lay-away vats" are of different sizes in different tanneries; the common size being nine feet long, seven feet wide and six feet deep; but those in the yard of The American Oak Leather Company, at Cincinnati, Ohio, are eight feet deep. In these vats the hides are placed one by one, spread out flat, and a thin layer of dry ground bark is sprinkled over each hide, in order that the liquor may circulate uniformly. This bark should not be ground too finely, or it will pack so tightly as to prevent the circulation of the liquor which would result in imperfectly-tanned leather.

After the hides have "laid-away" for a sufficient length of time to extract the tannin partially out of the "liquor," they are taken out and the liquor run off into a receiver through wooden pipes and pumped by steam power back to the leaches, where it passes through the bark and is re-strengthened and then run in new liquor into the tan vats, and the hides are then put back as before.

Each pack is usually "laid-away," that is, given new liquor from four to five times, the light hides are "laid-away" four times and the heavy hides five times, the whole operation in the "lay-aways" extending over a period of nearly four months for light leather and four months and a half for heavy leather.

The following schedule is from one of the largest and most successful tanneries in the country, and it will give an idea of the time and strength of liquor employed in each layer:

Heavy Hides.			Light Hides.		
Layer.	Length of time.	Strength of liquor.	Layer.	Length of time.	Strength of liquor.
1st	14 days.	30 deg.	1st	14 days.	30 deg.
2d	20 "	28 "	2d	20 "	30 "
3d	25 "	30 "	3d	30 "	34 "
4th	30 "	36 "	4th	50 "	45 "
5th	50 "	45 "			
	139 days.			114 days.	

Hides after coming from the "handlers" go into first layer. The liquor used for this layer is the liquor taken from a tanned pack, and is fifty days or more old and never very sour. This liquor is strengthened with extract to about 30 degrees barkometer, and heavy hides are laid away for fourteen days with bark as has been described. The pack of hides is then drawn and then laid-away again in a fresh sweet bark liquor which has been strengthened with extract to about 28 degrees, where they remain about twenty days. Pack is again drawn and put with the third layer, which is a fresh sweet bark liquor strengthened with extract to about 30 degrees barkometer, where they remain for about twenty-five days. Pack is again drawn and put into the fourth layer, which is fresh sweet bark liquor strengthened with extract to about 36 degrees barkometer, and where they remain for thirty days. Then the pack is again drawn and placed in the fifth layer, which is fresh sweet bark liquor strengthened with extract to 45 degrees barkometer, where they remain for fifty days.

The light hides are laid away only four times, the length of the layers and strength of the liquors being indicated in the schedule. The strength of the liquors should be determined by chemical analysis, which shows that the amount of tanning substance per degree barkometer in sweet fresh liquors in-

creases directly as the degree of barkometer. As an example: A ten degree chestnut oak bark liquor contains about 1.25 per cent. of tanning substance, a twenty degree liquor contains about 2.50 per cent. of tanning substance, and so on.

The hides after being tanned are taken out of the vat and split into sides. The sides are now rinsed in the liquor in which the tanning has been finished and are then piled to drain, say over night. The sides are then oiled on the grain side with cod oil, fish oil, or a mixture of mineral and fish oils. The oil is applied with a sheep-skin swab or a cloth swab.

The sides are now hung up on sticks, which are partially rounded upon the edge that comes in contact with the leather, in the drying room to dry. The sticks upon which the sides are suspended in the drying loft, are 2 in. x 2 in. and 8 ft. long; two sides are suspended upon each stick about one foot apart, and a passage-way 6 feet wide is maintained in the centre of the loft, and on each side of this passage-way two rows of sticks for holding the sides are placed.

The drying room is heated with a suitable steam pipe system so arranged as to distribute the heat gently and uniformly, and fans so placed as to draw off the moisture from the drying room as fast as it is given off by the leather.

In drying sole leather it is very desirable that too much light should not be allowed to enter the loft, as it is injurious to the color.

The temperature of the drying loft is kept at 70° to 80° F., care being observed not to get the temperature too high. In the summer time the loft is kept closed and the room darkened, some tanners even going to the expense of having double shutters on the windows.

With an intelligently constructed drying-loft, sole leather wet from the vats can be dried in forty-eight hours, ready for the roller, but some tanners prefer to dry it for a longer time. When the sides are thoroughly dry they are taken to the rolling room, which is well lighted, and dipped in clear cold water, and when the leather is hard it is dipped in a warm water bath.

The sides are now piled and covered and allowed to "sammy" or become of a uniform temper. They are then rolled and hung up in the loft to dry, and when dry are ready to be sorted for market.

The above description is for leather with a bloom.

The question is often asked us: "How much or what per cent. of rough leather can be obtained from the various grades of hides." Our answer is as follows:

	Oak.	Hemlock.
Green Salted Hides.....	about 50 per cent.	55 to 80 per cent.
Dry " "		112 to 122 "
Flint " "		160 to 175 "

For scoured leather the hides are split and rinsed the same as has been described for the unscoured leather. The sides are sometimes milled, and then they are scoured by means of a Monk Scouring Machine, shown in Figs. 50 and 56. The sides are now drained and oiled as has been described for unscoured leather, or they may be oiled in a mill. They are then hung up to dry and when dry they are dipped in water, "sammied," rolled and hung up to dry, and when dry rolled again, when they are ready to go to the sorter and be selected for the market.

This description is intended to cover modern tanneries which use tanning extract. In tanneries where no extract is employed the liquor may be several degrees lighter, and the length of the "lay-aways" slightly increased.

In some tanneries the hides are split into sides either as they come out of the soaks or out of the limes, especially when the tannery has smaller size vats than 7x9 feet.

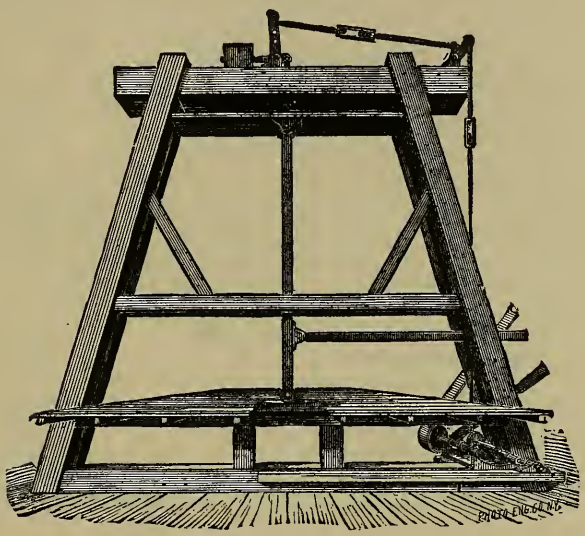
The tanning of the whole hide is more economical in labor in the yard, but the tanning of sides is more economical in the beam-house work.

The rolling machine shown in Fig. 111 is the kind generally employed for rolling sole leather. The rollers of these machines are made of brass, and are six inches in diameter and six inches face or length, and are turned to a true surface and

work into roller beds on concaves, which are also of brass and planed true to the radius or length of the vibrator or pendulum of each machine.

The pressure of the rollers upon the leather is imparted by means of levers connected with the vibrator or pendulum of each machine, and controlled by a lever worked by the foot of

FIG. 111.



the operator. The hook to which the foot-piece is connected is shown in the illustration of the machine. After the roller has passed over a portion of the side two or three times, it is shifted by the hand of the operator until all parts are successfully operated upon.

These machines are built by the Eureka Bark Mill Co., Lancaster, Pa. J. A. Brownell, Binghamton, N. Y., builds a good under pressure sole leather rolling machine.

CUT SOLES.

By the competition in trade many tanners are forced to cut soles, which are sold direct to shoe manufacturers. Men's out-

soles are cut from packer Texas hides, scoured oak barks. Women's outsoles are cut from scoured oak barks from packer

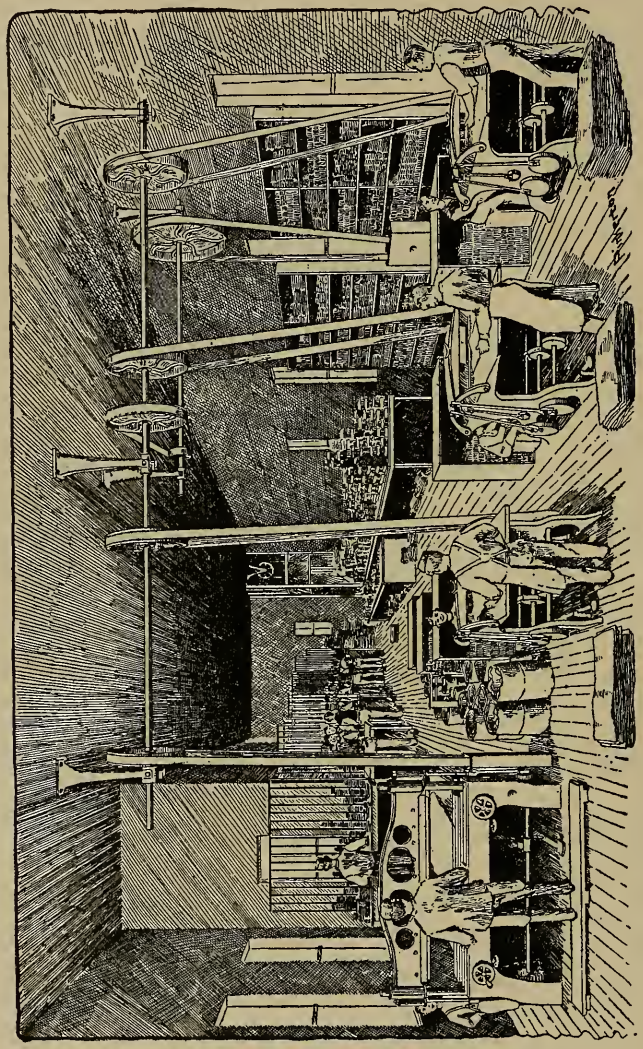


FIG. 112. CUT SOLE FACTORY.

native hides. The inner sole stock comes from the same class of hides, but from that portion which is not good enough for

outer soles. Goodyear insoles are cut of an oak bark especially tanned and finished for that purpose. Counters are made flat and moulded. McKay and Goodyear counters are made out of scoured oak bellies. Counters for Turn shoes are cut from light scoured oak shoulders.

One of the largest dealers in leather and findings recently said that trade in sole leather is carried on very differently from a few years ago. Then he had in his store constantly not less than 2,000 sides. Now he thinks he is overstocked if he has more than 200 on hand. The reason of this is that shoemakers buy most of their leather already cut. They can obtain it cheaper this way, and the bother of cutting is done away with. "Some of my customers in the immediate vicinity," says he, "do not carry any leather on hand. When they get a pair of shoes to tap they come in and buy the soles for them."

An interior view of a cut sole factory of Ackerman & Brummel, New York City, is shown in Fig. 112.

CHAPTER XXV.

HARNESS AND BELTING LEATHER.

NATIVE steer and heavy cow hides, free of brands and other blemishes, are used for this variety of leather. The beam-house preparation of the hides does not differ materially from that of hides intended for heavy upper leather, except that the liming should not be as high nor the bating as low as for heavy upper leather.

Harness hides should be thoroughly cleansed from lime before they are sent to the tan yard; this may be easily accomplished without the use of deteriorating excreta or extracting the gelatine, but so swelling the fibrine that it will receive the tannic acid, and blend readily and perfectly, giving firmness without destroying the elasticity or causing a tendency in the grain to crack when in use as harness, etc.

It is absolutely necessary that a thoroughly serviceable leather, which ensures the desired softness and pliability, and at the same time is free from a tendency to crack or get hard in use, should be used in harness making. Harness leather must be a great deal more flexible than either sole or heavy belt leather, and must have as high a degree of tensile strength as can be retained in the course of manufacture, while its surface must be fine and such as will readily take a variety of kinds and styles of finish. Lighter hides are, therefore, used more generally than heavier ones, yet, even then, there is no effort made to combine with the gelatinous body in the hide-cells as large an amount of tannins as the latter will take. A more thorough working over of the surface then becomes necessary, and a very considerable amount of dressing or stuffing of tallow and grease is, therefore, worked into it, while this, what-

ever the coloring may be, will bring the product, in many cases, very nearly to the substance of a leather generally used for the uppers of boots and shoes. As we get to the lighter leather used for harness purposes, upper leather for boots and shoes, and for goods of a miscellaneous character, the tanning proper, although always a matter of very great importance, loses here some of its former purpose, and the work of the currier and finisher then becomes a prime essential in the manufacture.

It is perfectly proper that the skins and lighter hides used to manufacture these proportionately light goods should not contain as much gelatinous matter in their cellular tissues as would the thicker and, consequently, heavier ones chosen for the tannage of sole leather; and they, besides, are not treated with tanning liquors of the same concentration as would be required for such heavy goods.

If too concentrated solutions of tannins are used for skins and lighter hides, the natural consequence will be that the products of such a tannage are substances altogether the opposite of what we require for saddlery and harness manufacturing purposes; flexibility and tensile strength would be lacking. It must be admitted that the kinds of the lighter goods in the market are much more numerous than are those used for soles and for heavy belting, and their qualities vary more widely. but by far the larger proportion of the goods made for such use—from the skins of calves and partially grown cattle, as well as those from larger hides in split form—are tanned with the same tanning materials as are used in manufacturing certain heavier leather.

It will not be inappropriate here to make a few remarks on belting for lighter purposes, as this is analogous to certain parts of harness; and it must be remarked that, as it should have greater flexibility than is found in heavy sole leather, the tanner must avoid filling the cells of the hides too thoroughly with tannins. If these rules are not observed, the natural position of the fibrous parts of hides may be disturbed.

It must be remembered that these fibrous bodies give the whole structural substance its tensile strength, although the fact may be acknowledged in a general sense only. For one thing, it is correct in theory, and it must also have some bearing on practice; and it is certain that it insures to the lighter kinds the same tannage, providing the varying precautions necessary are duly observed. The distinction between different kinds, so far as this rests in the substance of the texture itself, may be more theoretical than practical when viewed in regard to the common usages of the trade, but certain important distinctive properties traceable cannot be disputed.

All the large hides and sides of patent and enameled leather for harness and carriages are split goods, and are generally of the largest spread that can be obtained. Three splits are frequently made, the first being taken from the flesh side, and termed "junior." The small splits are usually deficient in strength, and cannot therefore be recommended for purposes where a fair amount of tensile strength is requisite, or where general safety is placed at stake through their use.

Chrome tannage is now being introduced for the tanning of both harness and belting leather, and it makes a strong, tough fabric.

An extract company of West Virginia are the owners of a quick tanning process by which they claim to be tanning No. 1 harness leather in 40 days and the best oak sole in 60 days by the use of their process and their refined chestnut oak bark extract. They have practically demonstrated to many tanners that, with the proper use of refined chestnut oak bark extract and the new method of handling their hides, the cost of their tannage is reduced from 15 to 25 per cent.

CURRYING HARNESS LEATHER.

Harness hides and backs, after soaking, should be shaved over with care, only taking off the flesh, so as to leave a smooth, even surface. They should then be well scoured on

flesh and grain out of liberal baths of tolerably warm water, which opens them and allows them to be better extended and slicked out as firm and free from water as possible; they are then ready for the shed. They require to be well set, keeping the straight edge in a line with the front edge of the table. Two men are generally employed at this work, and each should stone so that they cross each stroke, laying the goods out perfectly flat and firm, and then with a thick steel slicker take out all the stone and other marks; then oil them on the grain with good oil and turn over for stuffing on the flesh, which must be done without folding or creasing the hide or causing any contractions. Hides dressed in full length should have a loop at each end and one near the centre of the backs to prevent their drying baggy. When nearly dry they require resetting, the parts that are too dry being damped so that the hide or back is equally moist all over, and by keeping the table wet before each side is set it will prevent unnecessary removal of grease from the flesh. Scarcely too much labor can be bestowed here, as it should be the consolidation of the pattern prepared in previous stages. The grain should be carefully slicked again, so that no tool marks are left, and when dried out the sides are ready for blacking, which by some is done by brushing them over with urine and soda or fuller's earth, but we prefer very hot refuse sumac liquor and fuller's earth, as it requires less wetting and is cleaner. Every grease spot should be removed or it will not receive the dye, and be the cause of much extra labor when it cannot so well be done. They will now require the final setting, which will be but very slight if it has been properly done in scouring and stuffing. Care is again required here to leave no tool marks, and to facilitate a good grain surface a heavy glass slicker should be used. They should then have a good dressing of tallow dubbin on the grain and finished drying, when they may be laid down for stock or the grease slicked off, and have a last dressing of hot tallow on the grain. This gives a polished surface after laying a short time.

The same process will be sufficient for brown harness

leather, leaving out the part for blacking, and where the color is required to be bright a good sumacing will greatly help it, and the stuffing can be adapted accordingly.

Bridle butts, bellies and shoulders, after soaking, should be shaved clean, all the flesh being taken off, then well set out on the table with stone and slicker, so as to fully extend them and get out all contractions, then be again shaved to the required *level substance.* When they are ready for scouring, some curriers object to warm water, but it is very necessary for these goods, as it not only aids in cleansing, but it opens or rather mellows the fibres so that the leather may be fully extended and laid flat; they should then be placed in a tub or vat, with sufficient warm water to cover them without pressure, and be firmly slicked out on the flesh and well brushed over and put back into rather warmer water than before, but not hotter than the hand can be held in, as heat in this state of leather that will not injure the flesh of the operator will not injure the article operated on. They must now be well scoured on the grain. A stone slicker is the best for this part, if not too coarse, and after an extra good brushing be put again into clean warm water and sleaked out tight on the grain for compoing. We give this rather fully, as color depends so much upon how this part is done, and cannot be remedied if neglected. They should now have a good sumacing, each one being dipped separately and quickly while the liquor is hot; and when all are done, stir the liquor up well, as the bottom holds the heat and would burn the goods that came in contact with it, though the surrounding liquor is cool; and when it is well settled put them in one at a time, having sufficient liquor that they are not pressed, and pull them out next day; let them lay an hour and lay them in as before, and the next day they will be ready to slick out again, which should be thoroughly done. They may now be hung in shed for a short time, only sufficient to absorb the moisture that would slick out on the table and not approach to stiffness or dry in any part, then set them out on the grain firmly, keeping the edge of the butts (where cut down the

back) in a straight line with the table, and leaving no tool marks in. Give them a thin dressing of good tallow, dubbin and turn over; lay them flat with a thin slicker very lightly, stuff them with dubbin made with the best cod oil and pure tallow, as stiff with tallow as it can be spread, as its properties are the most value in these goods, producing mellowness, brightness of color, and facilitating a glossy finish. When they are about half dry they should be lightly set and hung up to finish drying, and may be sleaked off and glossed when required, but will improve by laying a few weeks before finishing.

The old-fashioned oak bark tannage is still used for harness leather; the best leather is from Chicago packer native steer hides, which make a tough and durable leather; they are clean shaved all over and stuffed with pure oil and tallow, carefully trimmed and closely selected.

Curriers' Skirting—This is for finishing skirting and the flesh of harness leather in imitation of oak tanning. Take of chrome yellow, ½ lb.; yellow ochre, 1 lb.; cream of tartar, 1 oz.; soda, ½ oz.; paste, 5 quarts; mix well. This will finish twelve sides.

GERMAN HARNESS LEATHER.

Green hides, if possible, are used for these varieties. As many hides as can be placed in the lime pit are, after cutting out the horns, soaked in running water six to eight hours with frequent rinsing, next cleansed from dung and placed in weak milk of lime for twenty-four hours. They are then taken out and replaced, after preparing fresh lime for twenty-four hours more, when they are again handled. After this they are regularly handled. Depilation is effected as soon as the hair can be easily pulled out, after which the hides are soaked in water for a few hours. Water stripes and dots are produced by soaking the hides too long in running water and allowing them to remain stationary. After fleshing and soaking for twenty-four hours the hides are smoothed and placed in the bate for one to three days, according to their thickness and the state of the

weather. They are handled three times every day they remain in the bate. If the England wheel is employed, the bating can be accomplished in from eight to ten hours. Special attention should be paid to this process, as soft leather can only be produced by proper bating, while too much bating is injurious, as it destroys the skin fibres and the grain. After taking the hides from the bate and rinsing in fresh water they are again smoothed, and after soaking for several hours thoroughly worked upon the flesh side with a dull fleshing-knife. They are then ready for tanning.

Salted hides of cows and oxen are soaked three days, special attention being paid to removing all the salt before placing the hides in the lime pit. Dried hides, after thoroughly soaking and bringing them back to their original shape by stretching, are treated in the same manner as green hides. By using the hide mill much labor in stretching and smoothing may be saved, and for inferior hides slicking also.

The handling vats should be sufficiently large to allow of the convenient handling of the hides.

It is generally preferred to place the leather in old liquor for one or two days, according to the quality of the liquor in the vat. The leathers are taken out and replaced and treated in the same manner as above, after ladling out the old tan and adding one-third bushel of fresh tan. According to the state of the weather the power of the tan will be exhausted in four to eight days, it then becoming necessary to freshen the vats. After doing this twice or three times more the leathers are placed in the lay-aways, where they remain for about the same period as for sole leather, a longer period being, as a general rule, only required for stout harness and vache-leather, but it is absolutely necessary for belt leather.

In order to see how far tanning has proceeded, it is advisable to split the leather after the second layer. The cut of a thoroughly tanned hide will be uniformly brown, while a pale yellow or white coloring is a proof of insufficient tanning.

After splitting the hides into sides and numbering the two

halves with the same number, the completely tanned leather is rinsed in old ooze and smoothed with a dull fleshing knife upon the beam. Where all three kinds of leather are made, the best hides are used for harness leather, the strongest for belt leather and the poorest for vache leather.

The harness leather is gone over with a fine-edged knife and then greased upon the flesh side with a mixture of linseed oil and tallow and hung up to dry. Vache leather is also greased, but only slightly, upon the grain side, and then dried.

PREPARATION OF VACHE LEATHER.

The dry hides are soaked in sufficient well water to cover them in a vat, handled after an hour, then replaced and allowed to soak over night. The next day they are placed upon a wooden table, and after tucking in the shanks rolled up, grain side in, from the head to the tail, so that every half hide forms a roll. The rolls are tied together with strong twine or leather straps, so that they will not become unrolled in the succeeding beating with fluted wooden mallets, which is continued until the hide feels soft to the touch.

To soften the hides completely they are boarded, after beating, upon the grain side with a coarse graining board. After working ten or twelve hides in this manner, a thin shaving is taken from the flesh side. The best plan is to have two workmen perform the above operations, and also the succeeding ones. In tanneries provided with a fulling mill, a higher degree of suppleness can be imparted to vache hides by fulling than is possible by beating and boarding with the graining board.

One-half of the hide is then placed upon a somewhat inclined table of wood, slate or glass as long as the hide and as wide as one-half the hide, and scrubbed with brushes constantly dipped in water until the flesh side acquires a mushy condition, which can be recognized by the impressions made by passing the fingers over the hide remaining visible. It is then turned over, and, after placing the back part in a straight

line with the edge of the table and passing the hand over the hide so that it sticks to the table, the grain side is treated in the same manner.

The slicker is then driven first along the back to prevent the wrinkles which are formed from sticking and then in the direction from the back to the foreshank. After removing the wrinkles, which is absolutely necessary, more force may be used for the removal of tan depressions.

As soon as one-half of the hide is slickered it is immediately hung up in the drying loft. If this is higher than the length of the hide, the latter is nailed through the hind shank and root of the tail to short strong sticks, or incisions are made in these places, and after passing through the sticks the latter are placed between two poles.

If the loft is not very high, the back part of the hide is nailed to straight, strong poles, which after tying the front and hind shanks with twine in such a manner that they cannot hang down and form wrinkles, are placed in the pole rack.

After the hides are partly dry, they are placed separately upon the table, and, after wetting slightly such parts as have become too dry, one hide is placed above the other and the pile repacked. The hides, moistened first, are then replaced upon the table, and after fitting the back exactly to the edge of the table it is fastened with a few wooden clamps, the impressions of which are removed later on.

To remove all tan depressions and to give the leather a beautiful appearance and firm touch, the use of a roller is of great advantage, especially as it facilitates the currying and prevents the grain from being injured by constant working.

The tan impressions, etc., are then entirely removed, and after rubbing with a moist woolen rag, the sides are stamped and hung up.

Before the hides become entirely dry the halves are fitted together according to the numbers, and placed grain side upon grain side and hide upon hide until a pile is formed, which is covered with planks somewhat loaded.

After remaining here for twelve hours they are hung across poles and gradually dried. Each hide is then rolled up separately and about six placed in one bundle, which is secured with twine.

It is scarcely necessary to say that scrupulous cleanliness must prevail during all these operations. By strictly following the directions given, an article fulfilling all demands will be the result, and one which is not only equal to the best Frankfurt vache leather, but in most cases surpasses it as regards beauty and quality.

After the harness leather has passed through all the above operations, it is sorted into brown and black. The first acquires lustre by means of a glassing machine or is sold without it. The black leather, after grounding with decoction of logwood, is blacked with iron black and, when nearly dry, passed through the press.

The best qualities of light hides from Buenos Ayres, Montevideo and Texas may also be used for vache leather. The lime used for hides intended for vache leather and inside sole leather, is sometimes mixed with red arsenic. This has a better effect upon the hide, also softening hard places found in these hides, which are always difficult to soften. In using this mixture the hides require more frequent handling than in the ordinary liming process, and should be depilated as soon as possible. As the hides are not raised by the mixture, it may also be recommended to subject them to the ordinary liming for a day, after taking them from the arsenic and lime liquor. This method of liming can also be advantageously employed in preparing green hides and kips for upper leather, but the after liming must be contiuued for a correspondingly longer time.

DRUM TANNAGE.

Drum tanning for harness, strap leather, etc., is growing steadily in favor. If properly conducted, drum tannage produces leather fully equal to that produced by older methods, both as regards quality and appearance. There is no doubt that

this mode of tanning would be far more generally practiced than is actually the case, were it not for the heavy royalties exacted by the owners of the patents and for the fact that a powerful motive and mechanical equipment, available in very few tanneries, is required. Tanneries constructed in future specially for making these kinds of leather will, however, henceforth doubtless have to be planned with a view to drum-tanning.

INDIAN HARNESS LEATHER.

In an article by Walter G. McMillan, read before the Society of Chemical Industry, the author stated that the Director General of Ordnance in India asked him to undertake a series of mechanical tests with the object of ascertaining the tensile strength of harness leather made in the Government Harness and Saddlery Factory at Cawnpur, and to compare it with that of samples made in private tanneries in Madras and in England. Several hundred tests of various kinds were made, and it is proposed, with the sanction of General Walker, to summarize the more useful of these results in this short paper. Visits to the Cawnpur factory have enabled the writer to give a sketch of the system of tannage by which the leather was made, and thus to give additional interest to the research.

The factory is worked by the Ordnance Department of India, under the immediate superintendence of officers of the Royal Artillery. The foreman is an experienced English tanner, and he is assisted by several staff sergeants instructed by him in such details as are required to enable them to supervise the native workmen in their own departments. The tannery is of no mean size, there being usually from 35,000 to 40,000 hides under treatment in the tanyard at a time. The currying and the subsequent fashioning of the leather into harness and saddlery components are conducted in the same establishment.

THE SYSTEM OF TANNAGE USED IN THE CAWNPUR FACTORY.

The factory is situated on the banks of the Ganges, close to the point at which it is joined by the Ganges Canal, and it is from this latter source that the water supply is drawn. The following numbers are the results of an analysis of water from this canal made by Dr. Compigne in the autumn of 1867, and recorded in a Government publication:

Degree of total hardness	4.7
Degree of permanent hardness	2.8
Solids in 70,000 grains of filtered water	8.26
Mineral matters	7.56
Earthy salts, etc., insoluble in water	5.07
Lime as carbonate	2.6
Soluble salts	2.5
Sodium chloride	1.5

With the exception of the somewhat large percentage of suspended matter—a difficulty met by allowing the supply to stand in settling tanks before use—the water appears to be suited for the work of the place.

The hides are for the most part buffalo and cow hides, which come to the factory from different parts of India very lightly salted, while a few are obtained green from the Cawnpur butchers and require immediate treatment. They are said to be fairly well flayed as a rule, with but few flesh cuts and little fat. Occasionally, careless handling prior to salting is found to have produced local putrefaction, which greatly deteriorates or destroys the skin, and is made apparent in the lime pits, even if it had not declared itself previously.

The tanning material used has generally been Babul (Acacia Arabica) bark, with a small proportion of myrobolans; within the last few months valonia has been substituted for the latter, but all the Cawnpur leather referred to in this paper was made with the addition of myrobolans. A few experiments were tried with a view to introducing the use of Sal (Shorea Robusta) bark in place of Babul, but the leather so prepared was somewhat hard and dark colored, and gave a distinctly inferior

test, as the numbers quoted hereafter will show. Babul bark, which is abundantly obtainable from local contractors, has been found by Christy to yield 18.95 per cent. of a good cream-colored tannin. A sample given to the author on the occasion of his visit to Cawnpur in 1893, gave 21 per cent. of tannin, while a specimen of Sal bark yielded only 9 per cent. The bark is said to be of fairly constant strength, showing only a slight loss of tannin (by exposure) during the rainy season. The exhaustion of the bark is effected in latches, which are worked in series of eight, giving different solutions, with a range of from 2 to 50 degrees barkometer. The latches are of brick, with wooden false bottoms, and are of three different sizes in different sheds. The sizes and weights of material employed are as follows:

Size of Latch.	Charge of Bark. Cwt.	Charge of Myrobolans. Cwt.
12x10x8	50	15
10x10x8	50	15
10x9x8½	35	10

The tan liquors are returned to be refreshed to one or other of the latches, according to the strength indicated.

The tanning process is conducted as follows:

The hides are soaked in pits in which the water is changed whenever, from its appearance, it is judged to require renewal. They are then stocked for about half an hour in a gentle stream of running water.

They are next limed in a series of six pits, each fresher than the last. The lime pits are, as usual, worked in a rotation, being made up originally with 5 cwt. of lime to the pit; this liquor lasts for about a month without further addition of lime, and treats 700 or 800 hides. Each hide may remain in the lime for from 15 to 18 days, but in the hottest weather a somewhat shorter soaking suffices.

They are now unhaired and fleshed, and are then bated in a liquor made up by extracting seeds from the pods of the babul

tree with water. This bate has originally about 2 cwt. of the seed to each pit, and lasts about three weeks; a gentle fermentation is initially set up by the addition of a few buckets of tan liquor. For light leather a bran bate is generally substituted. The process demands careful attention at all times, but particularly in the hot season.

The hides are now at once transferred to handlers containing weak liquors (7 to 8 degrees) for two or three days, being handled every two or three hours during the first day. The spent liquors from this vat are allowed to run to waste. After this the skins are handled daily for about a month in stronger liquor (15 degrees), then for a month in "floaters" in liquor of about 20 degrees; next they are transferred to "dusters," working at a strength of 30 degrees and containing a small proportion of fresh bark; here they are handled daily for from one to two months, and are then put away for about six months in layers, the liquor strength in which varies from 35 to 50 degrees, but averages 45 degrees. Each layer pit contains, in addition to the liquor, 4 cwt. of bark and 2 cwt. of myrobolans, and treats 100 hides.

CURRYING.

The hides are now transferred to the curriers' shops, where they are successively shaved to the required thickness, scoured on flesh and grain, passed rapidly through weak sumac liquors, oiled with cod oil, sammied and struck out, reshaved or flatted, stuffed with a mixture of cod oil and tallow (in equal parts in the cold season, but containing 60 per cent. of tallow in the hot season) and are finally dried out and finished by the removal of surplus grease.

In all the processes here described the average treatment has been given, but this must of necessity be greatly modified at different seasons in a climate which is equivalent to an English summer in the cold weather, where the thermometer may daily rise for several months to over 100° F., when a very small proportion of atmospheric moisture exists, and where for

two or three months the atmosphere may be saturated with water vapor with a thermometer indication of over 90 degrees.

Concerning the processes used in the preparation of the Madras and of the English leather, the author has no information. The latter leather, however, was taken from a large number of hides supplied to the Government by a good firm of English tanners.

The tests to be described were made chiefly with new leather. Half hides were supplied to the author's department and were cut, under his direction, in the manner detailed below. A certain number of the Cawnpur (Babul and Sal-tanned) English hides were made up at Cawnpur into harness components, were issued to a battery of artillery, and, after six months' service, were returned for test, and were then cut up into straps of suitable shape and size for the testing machine. The testing machine was one of Greenwood and Batley's lever pattern, and although intended and generally used to test metallic specimens up to a 100-ton load, was yet equally well adapted to the measurement of any stress exceeding 500 pounds.

TESTS OF NEW LEATHER.

The half skins being submitted, straps measuring in the test portion 10 inches in length by 2 inches in width, were cut from different positions in the hide.

The results of the tests were that the Cawnpur hides, as compared with English and Madras hides, both heavy and light, showed 8 to 10 per cent. greater strength at the average breaking stress and less stretch. The English hides showed greater resistance when wet than either the Cawnpur or Madras. The most absorbent and least dense leather in regard to water was the Cawnpur, next the Madras, and last the English. It was found that the narrower straps were proportionately stronger than a wide one, and that the weakening of a strap produced by the perforations to receive the tang of the buckles was nearly one-half.

Finally, to bring to a focus a few of the points which appear to be indicated by the experiments quoted in the paper:

A. In comparing the leathers produced by the two systems of tannage, that which had the lower specific gravity (wet or dry) was to a marked extent more absorbent than the other, and was at the same time stronger both actually and per square inch of section, but stretched less before rupture.

B. In leather produced by a green system of tannage.

1. Thin hides are stronger per unit of sectional area than thick hides, while the ultimate extension before rupture, although practically the same, is on the average slightly greater in the stouter specimens.

2. Thin hides are more absorbent and have a lower specific gravity when wet than thick hides.

3. In any given hide, omitting from consideration the extreme neck portion of the back, which is altogether inferior, straps from the rump half should carry a higher actual load by reason of their greater thickness, but will nevertheless stand a lower stress per square inch than those from the neck half.

4. With average hides, a comparison of strength per unit of sectional area is permissible, but shaving or an exceptionally severe use of the fleshing knife may lower the strength per square inch of section, while it increases the extensibility.

5. Other things being equal, a narrow strap may be expected to be not only stronger than a wide one, both actually and per unit of sectional area, but also to stretch more under a given load.

MACHINE BELT LEATHER GREASED WITH TALLOW.

By greasing with tallow this leather acquires the desirable property of not becoming hard, even if the belt cut from it has to pass, as is frequently the case, through water. This leather is tanned in the same manner as has been described for sole leather, complete tanning being the principal requisite.

After dividing the hides into sides and rinsing off the tan, the sides are scoured either by hand or machinery, so as to prepare them for the reception of the tallow. The sides are then treated differently from the leather that is to be used for uppers

of boots and shoes, in that they are not dampened and tempered, as has been described for heavy upper leather. But the sides, after being scoured, are dried in heat—in summer by spreading them out and exposing them to the direct rays of the sun, and in winter in a room having a temperature of at least 110° F.

Pure, best ox tallow, is melted in the meanwhile in a portable boiler, a temperature of 167° F. being the best for the purpose. This temperature should be kept up after the tallow is melted, which can be effected by keeping the boiler over a small coal fire, or, still better, by placing it in another boiler with hot water, which is kept hot over a fire while the work is going on.

One of the heated sides is then placed upon the table and the fluid tallow applied with a brush. The hide should be so thoroughly saturated with the tallow as to be entirely permeated with it, and the tallow applied to the flesh side so as to become visible upon the grain side. Should the tallow congeal upon the surface before permeating, it is allowed to soak in by placing the hide in the sun or near a warm stove; but if the hide is already thoroughly permeated, the excess of tallow must be removed.

CURRYING THE TALLOWED LEATHER.

The sides having lost their good appearance and become dark by greasing with tallow, are soaked in water for twenty-four hours and then placed upon the beam, and the tallow still adhering to the flesh side is removed with a blunt knife. After placing them again in water, each side is taken out separately, and after spreading it upon the table and covering with a layer of spent tan one-half inch thick, it is rolled up, and the roll, after securing it with twine, beaten with a mallet, until the leather has again acquired a light color and its original suppleness.

After rinsing off the tan the hides are again beaten, with frequent dipping in water in case they should feel too dry.

They are next smoothed in the same manner as for the ordinary machine belt leather.

It is recommended to have two men to do the work, it being too fatiguing for one.

The manufacture of this variety of leather, though very laborious, repays doubly the work expended upon it, principally by the increased weight the leather acquires by the absorption of tallow.

CURRYING STRAP BUTTS FOR MILL BANDS AND ENGINE BELTS.

Strap butts for mill bands and engine belts are generally made from good domestic hides, and sometimes from foreign of good growth, which have not been struck out nor rolled as sole leather, but merely dried out of the pits. The first thing to be done is to thoroughly soak them; they should then lay down two or three days to mellow, and then be shaved lightly over, only the rough flesh being taken off, the substance not being reduced. Some do not shave them at all, saying where a scouring machine is used that will take off sufficient; but straps and belts made from these manufacturers' butts are not so good in either wear or appearance. After shaving they should be put into water and lay at least one night and be well scoured first on flesh, then on grain, and be hung in shed to stiffen previous to being put in the stretching machine. Much attention is required at this stage that they be dry enough to retain the full surface acquired in straining, and not too dry to receive a fair quantity of dubbin in such a state as to amalgamate and form part of the leather. We have heard some professed curriers say the stretching is unnecessary and that they dispense with it, but their belts when made are far behind first-class, and must stretch themselves in use. Before the butts or sides are fixed to the machine we prefer having them well set on the table on the grain side, the flesh side having been brushed over with dubbin sufficient to cause it to adhere, and yet expand as it is worked upon. It will then be in a better state for yielding to the pressure required than if done after stuffing, and

should be lightly set after taking out of stretcher, and brushed over with dubbin and laid in packs ready for stuffing, which may be done when all are ready and hung to dry. These should be dried out before resetting, though they must be damped down after and then well set, and when re-dried should lay away a time before finishing. A good coat of tallow on the grain before laying away improves the quality and appearance. Where the butts are not stretched by machine, they should after scouring be well set out on the grain before stuffing, and when rather more than half dry be taken down and thoroughly set out on the grain, and then dried out and reset before laying down in stock, ready to be finished when required.

TO REMOVE GREASE FROM LEATHER BELTING, ETC.

The following method of removing grease from leather belting is patented in Germany and consists in subjecting the belt to a slow, dry heat after packing in dry powdered clay.

The belt to be degreased is rolled up in a spiral in such a manner as to leave from ¼ to ½ inch space between each convolution. It is then placed in a specially constructed box or other receptacle, the bottom of which is covered with a layer of powdered clay, and the space between the belt and the sides of the box, as well as the space between the convolutions of the spiral, packed tightly with powdered clay, the whole being lastly covered with a layer of the same.

The object of packing in the clay tightly, as described, is two-fold, viz.: To prevent warping and to insure contact with the clay at every point, and consequent perfect cleansing of the belt. The box with contents is introduced into an oven, specially constructed so as to give out an even heat from all directions, the latter being an important point, as irregular heating will warp and spoil the belt. The baking process is kept up until all grease has been extracted, which takes from 8 to 10 days, according to how long the belt has been in service, and the degree of heat to which it is subjected. The hotter the

oven, the quicker the operation, but it is not advisable to risk using too much heat, as the belt might thereby be easily ruined.

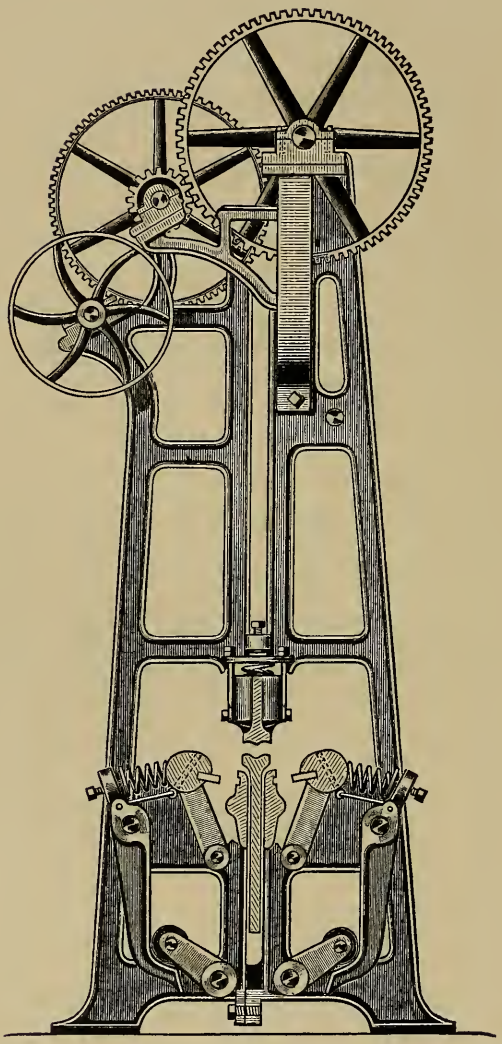
When satisfied that all the grease has been extracted, the box is removed and allowed to cool off gradually, or, better still, is left to cool off with the oven. A gradual cooling-off is absolutely necessary, as a sudden degree of temperature will warp and injure the belt. The precautions necessary to a successful result, the omission of all or one of which is fatal, are: Care in packing the clay closely and tightly; evenly distributed heat, and gradual cooling off.

The above process not only removes every trace of grease, it is said, but also acts as a preservative and stops all further stretching, one of the disadvantages of new belts. Being a dry process, it can be applied without injury to cemented belts.

WET STRETCHING MACHINE FOR BELT LEATHER.

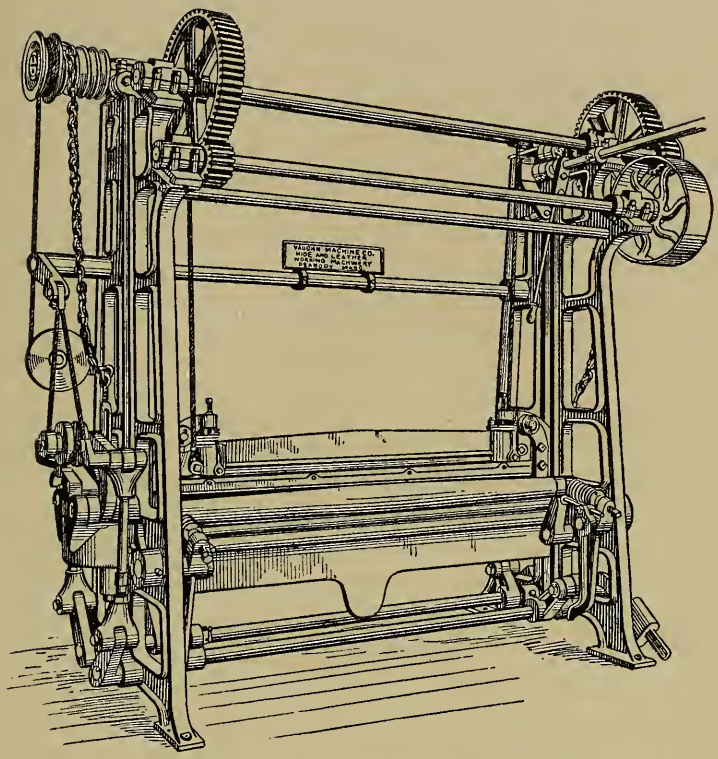
Figs. 113 and 114 show a vertical section and elevation of a wet stretching machine for belt leather built by the Vaughn Machine Company, Peabody, Mass. This machine is for wet stretching belt leather and it will do the work thoroughly, taking out all the stretch and gaining largely in measurement.

FIG. 113.



VERTICAL SECTION OF WET STRETCHING MACHINE FOR BELT LEATHER.

FIG. 114.



WET STRETCHING MACHINE FOR BELT LEATHER.

CHAPTER XXVI.

DANISH LEATHER.

UNDER the name of "Danish leather" is sold on the market not only glove stock but also leathers for various other purposes. Owing to its extreme suppleness, as much as owing to its beautiful color, this product has long stood in especial favor with consumers.

These desirable traits of Danish leather are secured mainly by a most careful preparation of the hides preparatory to tanning, thorough and favorable soaking and cleansing, combined with the use of willow bark as tanning agent.

It is hardly necessary to say that the best "Danish leather," so-called, comes from Denmark proper. In that country spring water is a rarity, and the many small streams and lakes are mainly fed by rain-water; the water is very soft, and particularly well adapted for the production from raw material treated with it of a pliable leather of most excellent feel. On the borders of these same streams and lakes thrive those very species of willow, whose valuable bark is almost exclusively used in tanning throughout Denmark.

The leather obtained by this willow tannage is of a light red, pleasing to the eye, and is readily worked into colors, yellow and brown shades being favorites among manufacturers.

Otherwise the tanning and currying differs but little from ordinary processes for upper leather, the main secret of success lying in the painstaking manner in which every detail of the handling, from raw hide to the finished article, is followed up.

Danish leather, even when intended for saddlery purposes, receives but little addition of grease, glycerine being used instead for softening purposes. This is a method comparatively

little known in connection with the manufacture of other sorts of leather except kid, and is applied as follows: By means of a sponge a very thin coat of glycerine is rubbed over the flesh side of the leather, which latter is then folded, flesh-side in. The glycerine by simply penetrating the leather, serves to retain its pliability. Frequently, it is true, a tanner will add a small proportion of grease to the glycerine, or give a light application of grease to the leather after it has become impregnated with the glycerine.

CHAPTER XXVII.

RUSSET LEATHER.

RUSSET leather is usually made from rough leather which is very carefully selected for shoe leather, so as to get it free from imperfections, such as brier scratches, grubs, salt stains, tanners' hook marks, chafed grain, arising from rough-edged workers in working out of the drench and from the short hairing knife.

Leather which is selected for bag leather and printed with a large figure does not show up the imperfections so plainly; and consequently, a lower grade of leather can be used for this purpose.

Large sides are used for bag leather and for strap leather, while the smaller sides are used for shoe purposes. The sides employed for strap leather may have some imperfections, but these imperfections may be dodged in the cutting. The sides selected for card leather and for shoe leather must be pretty nearly perfect.

The leather used for United States mail bags is russet, as is also the leather used for the bags carried by the U. S. letter carriers, and they may have more imperfections than card or shoe leather. Leather which is used for ladies' belts must be free from imperfections if the belt is not embossed. If it is embossed, it covers up a lot of the minor defects.

The russet leather which is used for bicycle seats and cases must be of high grade. The light russet leather used for whipstocks should be of good grade. The light russet leather used for book-bindings should be high grade. There are a large number of sheep-skins used for this purpose, but bindings of this character chip easily and are not so good as the light

russet leather. The highest grade of book bindings is made from calf-skins. Book bindings are also made from large and thick sides of leather which are then embossed and finished in imitation of seal and natural grains, and then split down very thin, about one ounce to the square foot, so as to give the appearance of a heavy, solid leather without the weight.

The straps which are used in street cars to hold to when the cars are crowded, as well as belt straps and register straps, must also be of high grade russet leather. Russet leather is also used for a large variety of purposes which have not been mentioned.

When the rough leather is selected and delivered to the currier, the first thing is to round it by cutting off the shanks, tails, teats, snout and other waste parts. The sides are then wet down and allowed to mull for about twelve to twenty-four hours. Then they are put into a pin-wheel and milled for ten minutes, so as to take out the stiffness and get them into better condition for working. They now contain about fifty per cent. of water, and are skived in this condition by running them through the belt knife splitting machine. The skiving is simply for the purpose of taking off the loose flesh, and, at the same time, giving a more even surface to work upon, and it also improves the appearance of the split, which is later on taken from the leather, and which, in most instances, is sold in the rough to the split finisher. The sides are then worked on the grain side on the stoning jack made for this special purpose, by J. T. Freeman & Co., Woburn, Mass., to take out the stretch and creases in the grain previous to splitting.

The sides are next piled on a table and sorted for thickness. They are usually divided into light, medium and heavy. Then the splitting machine is adjusted so as to take the lightest sides first, the medium next and the heavy last. The knife of the splitting machine is wearing back all the time, so that when the heaviest sides are fed to the machine the edge of the knife is in the right position.

The proper way to split shoe leather is to preserve the nat-

ural lines. The side of leather will finish best split with a gradual taper from back to belly and from butt to shoulder.

Card leather and strap leather have to be split pretty nearly of a uniform thickness. The leather is next given to the shaver, who cuts it over lightly on the flesh side to take out any little marks or inequalities left by the belt knife. The leather is then put into the pin-wheel with a weak solution of borax or other alkali and washed thoroughly. While it is still in the wheel, it receives a bath of weak sulphuric acid or other acid to neutralize the alkali and, at the same time, take out any iron stains that may be in the leather.

The borax bath is drawn off before the sulphuric acid bath is applied. The alkali bath works out the dirt and makes the leather appear much darker. The sulphuric acid bath changes the color of the leather to a much lighter shade than it was originally.

The sulphuric acid bath is then drawn off, and the leather receives a warm bath of Sicily sumac and alum, which makes the leather of a still lighter shade and at the same time softens it. The leather is then rinsed in clear water in a tank and is immediately struck out on the flesh side to remove the water and surplus sumac.

The leather is now in condition to dye or leave in the natural light color which has been obtained. If the light color is desired, the leather is hung up and allowed to harden, as it is termed in the East, or to sammy, as it is termed in the West, for setting. The setting is done by swabbing a table over lightly with oil, or paste, if no oil is desired in the leather. Then it is set out on the grain side with a setting stone, and afterwards with a brass slicker, to take out the stone marks. The leather is then hung up. Some tanners hang it on half round sticks; others suspend it by the head and butt with strings and allow it to dry. If the leather is to be printed, it is next dampened with clear water or flax-seed gum or egg albumen or milk, and is printed with whatever figure is desired. After it is printed, it is grained with a cork arm board and

hung up to partly dry. Then the leather is taken down and soft-boarded and hung up to thoroughly dry. After it is dry, it is staked by the staking machine. Then it is glazed with an agate or glass machine, and then it receives the final graining and is ready for market.

If the leather is to be dyed, it is put into a vat after it is struck out. The vat is about six feet square, and has a circular bottom and a paddle wheel about five feet long and four feet in diameter, hung upon a shaft about two inches in diameter, with fast and loose pulleys. This paddle will run from eighteen to twenty revolutions per minute. The vat usually stands about one foot above the floor, so as to draw off the exhausted dye. The vat is about five feet deep, and is partitioned off at one corner with a well about 10″ x 10″, which runs to the bottom of the vat. The well is pierced with auger holes, and the strong dye is put into the vat through this well and mingled uniformly with the water in the tank.

The leather has already been partially mordanted by the sumac and alum for certain shades. Some colors do not require any further mordant; but others do. The colors used are mostly anilines. The secret, if any, in dyeing leather is in preparing it for dyeing. Russet leather is dyed in a great variety of shades. As many as a dozen different shades, or more, may be obtained from the same can of color. After the dyeing is done, the leather is struck out on the flesh side and fat-liquored in the pin-wheel, and hung up to harden or sammy previous to setting. The leather is then finished in about the same way as the light-colored leather which has been described.

CHAPTER XXVIII.

GRAIN AND SPLIT LEATHER.

SATIN OIL FINISH; OIL GRAIN; PLOW GRAIN; GLOVE GRAIN; IMITATION GOAT OR PEBBLE GRAIN; IMITATION KANGAROO; IMITATION SEAL; IMITATION HOG; WAX CRIMPING SPLITS; FLESH SPLITS; DONGOLA, BUFFED LEATHER AND FLEXIBLE SPLITS, WITH STUFFINGS: PASTES, BLACKS, FINISHES, ETC.

In upper leather, buyers look for softness, suppleness, pliability, elasticity and waterproof quality; in bending it must not break, must have a nice grain and good color; it must be well worked, staked and grained and possess durability; it must have a full and plump feeling, it must have a delicate lustre, and the dear only knows what more is expected. Besides the above qualities, the buyer also looks for a fine grain on black leather, and this must be uniform, for leather can be considered handsome only when it is uniform. A uniform grain insures it against uneven contraction. By considerable work in slicking and setting out during the currying, these irregular grains may be worked out, but in graining or boarding it will always appear again to a greater or less extent, and never can be entirely remedied. This false, uneven grain may be prevented in two ways, that is by using weak liquors at the beginning of the tannage and by continued agitation while the skins are in the first liquors. In the first instance there is too little tannin in the liquor to cause a strong contraction of the grain, and in the second the constant bending of the skin by the agitation breaks the grain in every direction and prevents any break in one direction only. How nicely the grain is broken by agitation one can best see illustrated in English crown leather, where the grain in consequence of the constant stretching and lifting of the wheel becomes so regular that fur-

ther currying is not necessary, and the hide, so to speak, comes finished from the wheel. The stronger the liquor is the more apt it is to contract the hide. It is very injurious to commence the tannage with too strong liquors, and equally injurious to allow the liquors to fall away in strength. Commence with weak liquors and strengthen them, keeping up a constant agitation, until the grain has been formed, and the leather is so far tanned that the grain cannot contract.

Satin oil finish, oil grain, plow grain, glove grain, imitation goat or pebble grain, imitation kangaroo, imitation seal, imitation hog, wax crimping splits, flesh splits, dongola and buffed leathers are produced in large quantities in the United States in Massachusetts, New York, Pennsylvania, Illinois, Michigan and Wisconsin.

The bark used for the tannage of these leathers is hemlock, and is derived principally from Pennsylvania, Michigan, Wisconsin and Canada.

The hides used are chiefly slaughter hides, and are obtained from Chicago, Illinois, St. Louis and Kansas City, Missouri, Cleveland, Dayton and Cincinnati, Ohio. Boston, Massachusetts, and other points in New England furnish a few hides, but the supply from the latter sources is small.

The hides used for the varieties of leather under consideration are "buff hides," *i. e.*, those obtained from cows, heifers, and steers, and will average to weigh about fifty pounds each.

The first step in preparing them for the tanning liquor is to place the hides in the soaks of clean, cold water, and here they usually remain two or three days, the water being changed every day.

In soaking the hides they are placed on a stick the length of the back-bone, then they are hung low enough in the pit to be covered by water, which does away with the hoisting of the hides out of water. The plug is drawn each twenty-four hours and the water run off. The vats are rinsed of salt and sediment and fresh water run in.

The pits must be fixed for this process by a stick on each

side with pins far enough apart to admit the sticks upon which the hides are hung, and low enough to be covered by water.

After being removed from the soaks the hides are split into sides, and after being split the sides are fleshed by machinery, and are then rinsed in clear water and are toggled or tied together and then placed in the limes, where they remain for from five to seven days, being reeled into a vat of stronger lime each day. The power reel is used in some factories and the hand reel in others.

The limes must be cleaned every 14 days, beginning at head lime and cleaning every other day. This gives clean limes every 14 days, and the hides come out uniform from the limes and are ready for the bate and the wash reel.

The object of liming is to get the hair off, not to eat the gluten of the hide up. The sooner you lime and get the hair off, the less bating required. If you eat the gluten out you have nothing to build on for weight. This gives more weight and a closer and finer split, better flanks and heads.

The sides are next unhaired, which is accomplished usually by the machine process. Eight hundred sides of leather can be unhaired in one day of ten hours by the machine method.

When unhaired by machinery the sides are passed through a Vaughn or Whitney unhairing machine, and are then refleshed by machinery to take off the flesh "puffed up" or raised by liming or left on after the first fleshing.

The unhairing, fleshing and refleshing machines are fully explained and illustrated in Chapter VIII.

When the sides are unhaired and fleshed in this manner by machinery they are placed in a bate of hen manure (but pigeon manure is better), in which they remain from twelve to thirty-six hours, but when the sides are worked in the bate with the England wheel shown in Figure 35, the bating can be accomplished in six to eight hours, the time depending upon the weight of the hide and other circumstances, the object of the bate being to fully neutralize the lime, thereby giving a smoother grain to the leather.

After being removed from the bate, the sides are allowed to remain over night in a vat of clean, cold water, and are then worked out and short haired and washed in a wheel with a stream of water heated to 70° F. for two to three minutes. When the water runs off clear from the wheel it should be stopped, as the object of the washing is then accomplished. The sides are then tacked to sticks and suspended in the "handlers," containing hemlock liquor, which is increased from about three degrees strength at the start to twelve degrees strength at the finish. The sides are treated in these handler vats for about twenty-two to thirty days, being shifted continuously or daily into stronger liquor. Some manufacturers allow a small stream of liquor to run continuously into the vats; others strengthen the liquor daily.

After being removed from the sticks, they are allowed to drain for a few hours and are then pressed in a power press sufficiently dry for the splitting machine. They are next skived, usually by a belt-knife machine shown in Chapter XIII., one man being enabled by a machine of this character to skive 1000 sides in one day of ten hours. They are then stoned out on a Vaughn machine (Chapter XVI.), similar in construction to the setting-out machine; which machine will stone out 1000 sides a day, or on a stoning jack, shown in Fig. 39. They are then fitted or trimmed on a table with an ordinary shoe knife and are next split, usually by the same kind of a belt-knife machine which has been mentioned. Two men will split from 500 to 1000 sides in one day of ten hours; about 2½ to 6 ounces grain to the square foot being usually taken off the side in splitting it, depending upon the kind of leather which it is desired to produce.

The "split" is then trimmed by hand, and is then run in a pin-wheel with weak liquor for 15 or 20 minutes to take off the glaze caused by splitting, and then placed back in liquor of about eight degrees strength, which is gradually increased and remains for from twelve to fifteen days and sometimes longer.

The part from which the "split" is taken, called the "grain,"

is shaved on a beam with a currier's knife in order to take off any flesh or lumps which may be left on the thin flanks. One man will shave from fifty to five hundred sides in a day, depending upon the amount of work which the shaver has to do; sixty sides being a regular day's work, provided they are shaved all over.

They are then milled with either sumac or hemlock liquor, or both, for about one-half hour in a revolving drum, which is commonly about eight feet in diameter and four feet wide.

After being removed from the liquor they are next scoured in some few establishments, but scouring, unfortunately for the quality of the leather, has become a thing of the past in many of the large factories. After being scoured, if this is done, the sides are hung over poles and exposed to the air to harden, as shown in Fig. 115. They are then taken down from the poles and the dry spots dampened and are piled, and left to equalize for twenty-four hours. They are then carried to the shop and stuffed in a revolving drum, such as has been explained and illustrated in Chapter XV.; the operation of stuffing lasting from about thirty to sixty minutes; the drum being at a temperature of 160° F., and the grease at a temperature of 140° F.

Tannages are not all alike and of course cannot all be handled alike. The leather ought to be from three to four days ahead of the mill so as to be well mulled. Sometimes the leather is a little damper, then the mill and grease both ought to be a little hotter and run somewhat longer. In hot weather the leather must be turned every day to prevent heating.

After being stuffed, as soon as they are cool, they are thoroughly set-out, hung up and dried. They are then buffed and whitened, the grains are buffed and the splits are whitened.

These leathers are all stuffed differently. Satin grain, four ounces to the square foot, is stuffed from 40 to 45 per cent. of its wet weight; the stuffing being 35 per cent. English degras, 35 per cent. brown grease, 15 per cent. stearine, 15 per cent. wax.

Glove grain, four ounces to the square foot, being stuffed

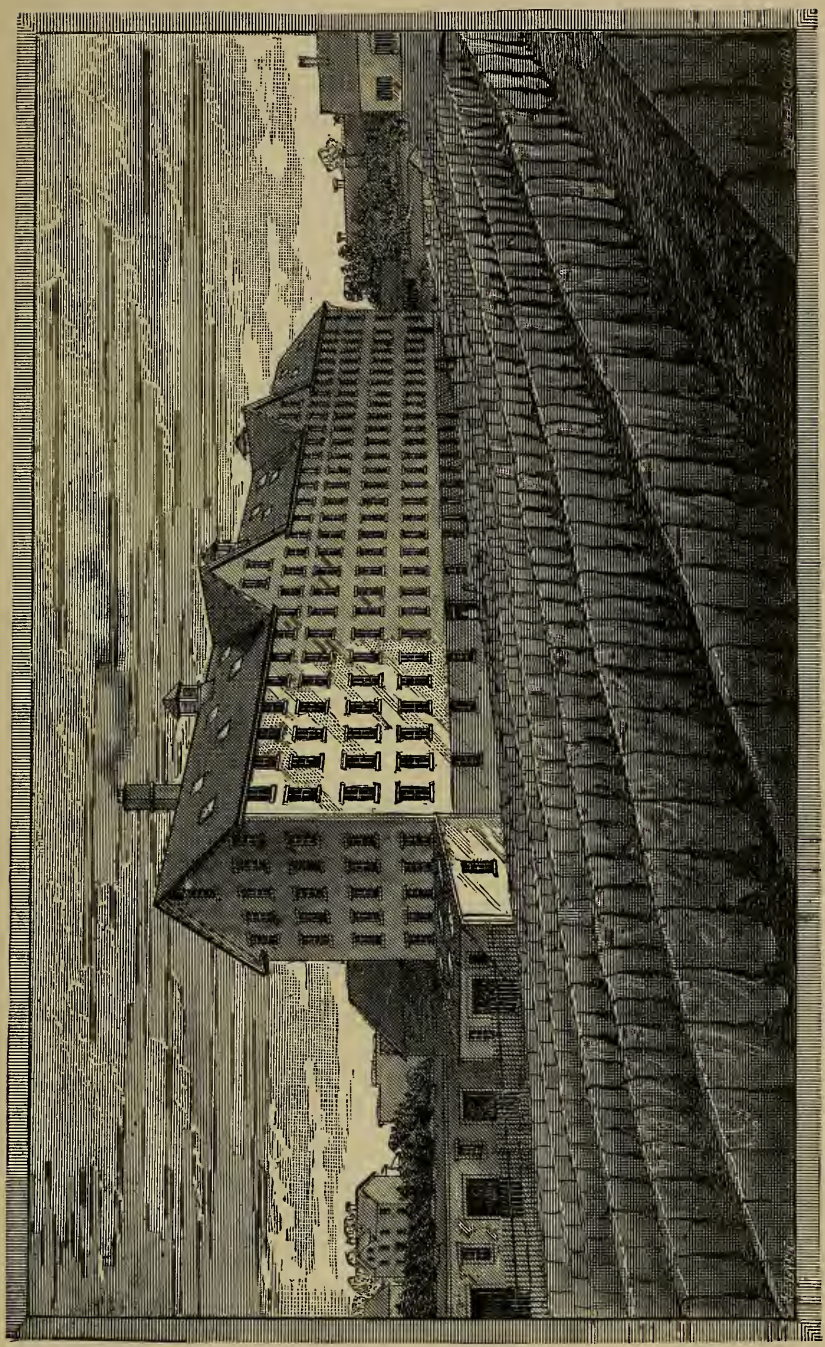


FIG. 115.

DRYING-YARD OF AN UPPER-LEATHER TANNERY—LOOKING TOWARD THE FINISHING SHOP.

about 25 to 35 per cent. of its wet weight according to its tannage. The stuffing is composed of 35 per cent. English degras, 65 per cent. brown grease.

Imitation goat or pebble grain, 4 ounces to the square foot, is stuffed lighter still, from 15 to 20 per cent. of its wet weight. The stuffing is composed of 30 per cent. degras, and 35 per cent. paraffin oil, and 35 per cent. cod oil.

Kangaroo and dongola are stuffed 20 per cent. with French degras. This is all the stuffing they get until they go on the setting-out table, when they receive a coat of cod oil on grain side. The next day, after being stuffed, the sides are set out, this now being done by the large firms with machinery.

The Vaughn setting-out machine for splits and stuffed leathers is shown in Chapter XVI. It is built by the Vaughn Machine Co., Peabody, Mass.

The sides are then struck out on the flesh by hand with a thin, sharp slicker, and then hung up to dry. They are taken down when dry and carried to the finishing room and stained on the grain side with a preparation of logwood and soda; one pound of logwood chips to one gallon of water, two ounces of sal soda being used to the gallon of staining. The sides are then immediately blacked with a solution of copperas or other preparation of iron. Generally eight pounds of copperas to the barrel of water is used, the barrel holding usually fifty gallons.

The staining and blacking is usually done with the Batchelder Blacking Machine, shown in Figs. 73 to 82.

This blacking is for satin oil, glove grain, plow grain, oil grain and dongola. Imitation goat requires a weaker solution, about five pounds copperas to the barrel of water being sufficient.

Satin oil, after being blacked, is hung up until the blacking dries in; take down, soft board, trim and roll, then give two coats of Victor No. 50 and Oil Finish Mixed ½ and ½. When most dry, roll and give another coat of same finish, then roll. Always roll while finish is a little moist. Leather treated as

above will come out with a strong black color and a dull face finish, well filled and a nice smooth feel.

Bright glove grain, after being blacked, is taken down and rolled with a smooth roller in a Combs or Freeman jack, and then hung up over night and taken down next morning, trimmed and pasted; reduce paste with Victor Finish No. 30, this softens paste and gives a strong color. When dry stake and roll, then give two or three coats of Victor Glove Finish, and when dry roll; always let each coat dry before applying another, have one man put on and another follow with fine sponge to streak off. This gives you a very bright and black water-proof finish. Leather will be well filled and have a nice soft feel, and it is then ready for market.

Imitation of goat or pebble grain is finished as follows: after blacking take and size the sides with one coat of sizing, hang up for five minutes until dry, and pebble it by machine, grain it four ways, straight and across, then angle it two ways, give the side a coat of Victor No. 4 finish, hang up all night, and the next morning stake or soft board and grain two ways, give another coat of Victor No. 4 finish, run it through polishing wheel, grain it two ways, oil it with hot paraffin oil, and it is finished ready for market.

Kangaroo chrome tannage, is finished as follows: after scouring, black it while wet, when blacked strike out on flesh, turn it over and slick on grain side, give a heavy coat of fish oil, hang up till dry, then trim it and stake it, soft board it, roll or glass, then the sides are ironed with hot irons, such as are used in any laundry, and it is finished with two coats of Victor dull finish, and it is ready for market.

Crimping splits are provided from the portion of the hide after the grain is split off, and are finished on the grain side. They weigh from 4 lbs. to 8 lbs.

The splits are put back in the liquors of 10° strength for 10 days to 15 days, and from the liquors they are hung up till dry, then taken down and dampened and left to equalize for 24 hours, stuffed with grease, composed of 25 per cent. degras, 50

per cent. hard or brown grease, and 25 per cent. of wax; they are stuffed 35 per cent. of their wet weight. The stuffing is done in a drum, heated to 165° F., and stuffing is heated to 140° F. The splits are then set out and hung up till dry. They are then taken down and piled full length for about one week on the floor, then they are cut over on flesh side and are then whitened by machinery on the grain side. One machine does both the cutting over and whitening, and will do about 300 splits per day of 10 hours.

Then the splits are pasted on flesh side with Batchelder blacking machine, and then glassed over the paste with a glassing machine; then they are blacked with lamp-black blacking on the grain side and glassed while wet; they are then pasted over the blacking and glassed again with a glassing-jack; they are then hung up all night, and taken down next morning and trimmed, glassed on both sides with glassing-jack; then they are finished with a solution of gum tragacanth, mixed with ⅓ paste and ⅔ gum tragacanth solution. This solution is made by placing 8 pounds of gum tragacanth in 8 gallons of water, and then adding water each day until it has come to the desired consistency. The solution is thoroughly stirred two or three times each day; then add 4 quarts of Irish moss solution. The solution of Irish moss is made by taking 10 pounds of Irish moss to one barrel of water and boiling for ½ hour. Then add one quart of cod oil, which completes the finish for wax crimping splits.

GUM TRAGACANTH FINISH.

To make 10 gallons of finish, take four pounds gum tragacanth and one quart of cod oil, and dissolve them together over night. Next morning pour three gallons of water at the boiling point on the mixture. Leave alone for four hours. Then stir well, and next day add four more gallons of boiling water. Stir occasionally and add two more gallons of boiling water a few days afterwards. If too heavy, add more hot water, and the mixture will then be ready for use. The cod

oil will take the dry tendency from the gum, and when applied to the leather will give a fine moist feel. If made as directed, this mixture will remain good and ready for use for five years. It is specially valuable for shoe shops. It will be found that the method here given for dissolving the gum is much better than when only water is employed. If water is hard, add a little borax.

PASTE FOR UPPER SPLITS AND CALFSKINS.

Mix seven pounds flour; seven ounces dry rosin; one gill ammonia; twenty ounces soap; two pounds white glue; six pounds tallow.

This paste, when applied in connection with the above preparation of tragacanth, should be used in the proportion of three-quarters of it to one-quarter of the prepared tragacanth. It will make a fine finish that will not peel or crack off. If the leather is open, use a trifle more paste to fill up.

BLACKING FOR SPLITS.

18 pounds of Babbit soap; 10 pound barrel lamp-black; 50 gallons of water.

Pyrolignous acid black is the best black to use for fine work.

PASTE FOR WAX STOCK.

Will make about a ten gallon keg: Five quarts flour, 10 ounces tallow cake, 4 ounces rosin, 6 ounces beeswax, 18 ounces soap.

This makes a nice filler and gives fine feel to leather. Will not peel off. Don't put the soap in until the other materials have been cooking one-half hour. Then add the soap, having previously cut it up fine, and stir till it is thoroughly dissolved. The ingredients will readily dissolve and the paste be ready for use, one hour after being made. Stir well when cooking.

IMITATION SEAL AND HOG.

Imitation seal and imitation hog are printed with rollers, which imitate the grains of those skins and are finished as is

bright grain. An embossing machine should be used in preference to a pebble for producing these grains.

PLOW GRAIN.

Plow grain is made from 40 to 50 pound hides, split in two in the hair. They are soaked and limed in the usual way. They are unhaired and fleshed by machinery, after which they are bated in a bate of chicken manure, 1½ barrels to 60 hides, in an England wheel. The bate is steam heated to 90° F., and is run for three hours, or until, in the judgment of the tanner, the sides are run down low enough. After being bated they are washed in a drum with clean warm water; the water is heated by a jet of steam to about 100° F. Then they are taken to the tanyard and hung on sticks in a weak liquor of about 5° Barkometer. Next day this liquor is pumped off and thrown away. The liquor is then renewed each day for 10 days, being gradually increased in strength up to 10 or 12° Barkometer. At the end of this time they are taken off the sticks and laid away in liquor of 18° Barkometer for 7 days, at the end of which time they are taken up and given a second layer of 20° Barkometer, where they remain for 8 days longer. They are then taken up again and should lay on top of the vats for 2 or 3 days, when they are ready to sammy (or semi-dry) for splitting machine. In cramped quarters, when it is not possible to sammy the sides properly, a power press can be used. The leather is next jacked on a stoning jack to take out the wrinkles, and is next skived on a belt-knife machine, and is next split to 7 or 7½ ounces to the foot thickness, and then shaved. The leather is then again sammied and dampened for stuffing, which is done in a wheel heated to 160° F., and the grease is heated to 140° F. The stuffing is 45 to 50 per cent. of the dry weight of the leather, and is composed of 60 per cent. hard brown grease, 20 per cent. stearine, and 20 per cent. English degras.

The leather is then set out either by machine or hand, and hung to dry, and when dry, which usually requires three days,

is taken down and snuffed with a buffing slicker. The leather is then stained and blacked in the usual way, and is then pebbled with a boot grain print, and boarded on the grain three ways, angled two ways and across from back to belly. The leather is then given a coat of heavy oil, composed of one gallon paraffin oil and two pounds degras, and hung up to dry over night. In the morning it is boarded again three ways on the grain the same as before, and is then soft boarded and given a light coat of oil. The oil is composed of one gallon of paraffin oil and one pound of degras. It is then hung up until the oil strikes in, and then taken down and given a coat of finish, the usual satin finish.

FLESH SPLITS.

Flesh splits are splits which are finished on the flesh side. The usual weight of the flesh splits is from 1½ to 3½ pounds. The splits are taken from the splitting machine, and shaved on the flesh side, and any large, loose veins should be entirely shaved out. The small, close veins should be merely split in the shaving. After shaving, the splits should be run through the splitting machine and leveled from the grain side. They should then be sammied and dampened ready for stuffing, which is 55 per cent. of their dry weight.

The stuffing should be composed of the following greases: 70 pounds Brown grease; 20 pounds English degras; 20 pounds refined paraffin wax.

This is for 170 lbs. of dry splits. The drum is heated to 160° F. and the stuffing to 140° F. The splits should be run in the stuffing wheel for thirty minutes, after which they should be taken out and hung up to cool for about thirty minutes, then taken down and placed in a pile opened out flat, and allowed to remain in the pile until the next day. They should then be set out on both sides by machine or hand, and hung up to dry which would require about three days. The splits should then be taken down and piled lengthwise on the floor and allowed to remain for about a week in piles. They are then ready for whitening,

which is done by hand with a whitening slicker. The veins should be cut out the same as a calf skin, and they should then be cut over lightly on the back and given a coat of paste on the back; the paste should be mixed with quercitron extract, and hung up to dry. They are then glassed by machine on the pasted side and then blacked on the flesh side and glassed out by machine, after which they are pasted on the black and hung up and dried out.

The splits are then glassed out of paste by machine and given a coat of oil if necessary, and are then given a coat of gum for a finish.

The finish coat should consist of ⅔ paste and ⅓ of dissolved gum tragacanth.

Oil grain is finished the same as plow grain, only it is a lighter leather, 5 or 6 ounces to the foot, and has a smaller pebble.

The bright finish for glove grain is composed as follows for 100 gallons: 10 lbs. borax to 12 gallons of water. The borax is boiled thoroughly in a kettle or tank with steam for ½ hour, or until borax is thoroughly dissolved. Then 50 lbs. of "Gernet Diamond C" shellac is thrown into the borax water, stirred thoroughly, and boiled till the shellac is all dissolved, which requires about 1 hour. Then take 75 lbs. of logwood chips and place them in a second kettle and pour over them 75 gallons of water and boil 1 hour with steam.

If a blue-black color is desired, dissolve ½ ounce of bichromate of potash to every 2 lbs. of logwood used and add it to the logwood liquor.

The logwood liquor is then poured into the shellac solution; both the shellac solution and the logwood solution must be at boiling point. The two solutions should be thoroughly stirred for 15 or 20 minutes, and then left for 24 hours until cold. Then take 25 lbs. of blood albumen and pour over it 5 gallons of water and allow it to soak for 10 hours, then stir well and pour it into the logwood and shellac solution, stir well and then add 21 gallons of beef blood under constant stirring. Then add

2 gallons of ammonia, stirring well, then put in 2 ounces of carbolic acid to prevent the blood from smelling. The quantity of ammonia is not fixed, as some leather will take more ammonia than others—in such cases the ammonia is added at the finishing shops. This finish is put on the leather by two men, one putting it on and the other striking it off after him. They both use fine, soft sponges. They give the leather two to three coats in addition to the paste, and it is hung up to dry for ½ hour after each coat.

Satin oil leather is finished as follows: It is made by putting on the leather one coat of bright glove finish, then take four quarts of the gum tragacanth solution, one pint of flour paste, one and one-half pints of cod oil, one and one-half pints of degras, then strain well with sieve or cheese cloth and put on the leather one coat of this mixture over the bright glove finish. This finish is put on in the same way as the bright glove finish.

Imitation of goat or pebble grain finish is made as follows: Four quarts of Irish moss solution, four quarts of flaxseed solution, four quarts of solution of sumac, six quarts of beef blood, add one gill of ammonia. Two coats of this solution are put on.

Kangaroo finish is made as follows: Sixteen gallons of logwood solution (prepared as in bright glove finish), fourteen gallons of beef blood and ten pounds of blood albumen (soaked as in bright glove finish), fifteen gallons of gum tragacanth solution (as in bright glove finish), then add one ounce of carbolic acid. Two coats are put on. This is for chrome or bark tanned stock.

Very bright pebble grain finish, soft and greasy feel: Blood albumen, one pound; water, one-half gallon. Soak over night cold, then add one-half gallon luke-warm water, stirring thoroughly. Strain through a cheese cloth. Then take one gallon of blue-black liquor and stir into it, and then take one-half gill glycerine, one-half gill of ammonia, mix thoroughly and stir into the above.

If you wish to obtain the most satisfactory results never attempt to make your own finish, as there are manufacturers who make a specialty of finish who can always serve you at a low price, and often give you valuable information in regard to stuffing and finishing the various kinds of leather.

BLUE-BLACK LIQUOR FOR FINISHES.

Two pounds best logwood chips, one-half ounce bichromate potash, one gallon water.

BUFFED LEATHER.

After the leather has been scoured, either by hand or machinery, it is pressed dry enough to set, after which it is "set out" on the grain side with a stone so as to make it solid, and free it from the grain, and it is then stuffed. This variety of leather is usually stuffed in the wheel, but is often stuffed by hand, and it is performed by laying the side of leather on a table, flesh side up, and working over it with a steel slicker, after which a preparation of fish oil and tallow is applied with a brush to the flesh side. The sides are then hung up in the loft to dry, being placed on sticks in tiers, and in this manner they remain until dry.

The superfluous grease is then removed from the flesh side by means of a slicker; but sometimes this operation is performed by a machine, which is called by the curriers a "grease jack."

The leather is now in condition for buffing, which is performed by placing the side on a slanting table covered with leather, and removing the grain by means of a whitening or buffing slicker. One man will buff from fifty to seventy sides of leather per day, the number varying with the condition of the leather and the skill of the workman, or the buffing can be done by machinery. In order to improve the appearance of the edges, the sides after being buffed are next trimmed around with a common shoe knife.

They are then placed on a flat table, fifty sides being piled one on top of another with the grain up, and the batch is then

blackened with a composition of logwood, water and sal soda, which is rubbed into the leather with an ordinary blacking brush, or the sides may be blackened by machinery.

After the pack has been thus treated the sides are then blackened with another compound of copperas water or other iron preparation.

The sides are then replaced upon the table, and are then "smutted," which operation is performed usually by working over the blacking with a woolen cloth in order to remove dirt and sediment, and improve the appearance of the blacking.

The leather is next glassed in order to make it "fine," and remove all the creases, and when the glassing is done by hand the side is placed on a table and the blacked portion worked over with a glass slicker. The sides are then hung up in the finishing room for a short time, and then "pasted," which is an application of flour paste over the blacking, and commonly put on by means of a sponge. After being thoroughly dried, the sides are "soft-boarded" by working them with the flesh side up, and one man will soften about 100 sides per day.

The leather is then laid upon the table and slicked off clean on the flesh side, and then immediately glassed on the grain side, after which it is gummed with a preparation of gum tragacanth, made of about the consistency of jelly, and applied over the paste.

The sides, after being hung up and dried, are then assorted, marked and bundled, and the buffed leather is ready for market.

FLEXIBLE SPLITS.

After splits are sorted at the belt knife machine, take them to the drum wheel. Then dissolve half a bale (a bale weighs about 250 pounds) of gambier, or the same proportion of extract, in a barrel of water, so that the liquor will stand at 80 degrees barkometer. Now bring this liquor down to 25 degrees by adding six pails of sweet liquor, 12 degrees barkometer. Put the solution in the mill, and let the splits follow. Close judgment must be used here. If the splits are large, mill

for 45 minutes. Remove and leave in piles for say 12 hours. Then throw them into a vat containing 20 to 25-degree liquor, and leave until well-tanned, say three or four days.

Take splits out and put in wash-wheel with plenty of lukewarm water through the axle of the wheel. Have plugs in wheel so that impurities may be washed out. The wheeling should occupy 20 to 30 minutes. Now take 50 gallons of water, to which add four pails sumac (about 20 pounds of sumac to a pail), and one pound of alum. Cook to the boiling point. Then let cool to 110° F. The splits meanwhile are still in the wheel, and to them should be added from four to six pails of the sumac liquor just made, and the wheel run for about 30 minutes at 16 revolutions per minute. Remove and rinse leather in clear running water.

Now heat 50 gallons of water to 120° F., into which put two quarts of sugar of lead. In another barrel of water containing 50 gallons, put one quart of vitriol. Immerse splits first in sugar of lead solution; then in vitriol solution; then in clear, running water. The leather is now ready to be sammied in the usual way like satin or wax splits.

After this is accomplished and the leather ready to set, it should be put under a setting-machine and well set, and then rolled down fine and soft. For setting, the splits should be as dry as possible. For instance, 100 pounds dry splits should not have over 35 pounds water after they are set by jack or hand. Now make the following: Three pounds Irish moss and one-half pound soap, and cook with three gallons of water and strain. The mixture, if properly attended to, will resemble a heavy cream. Set this on one side and apply a coat of it liberally to both sides of the splits. Then hang up in a warm room. When dry take down and leave in a pile to press for a day or so. Now prepare the following: Three pounds Irish moss, one-half pound chip soap, half pound starch. Dissolve this in cold water, say four gallons, and cook well. The result should be a heavy substance.

Take splits to jack. Have one man at jack and one man to

apply the mixture to flesh side first, taking the splits one at a time, giving liberal dose to the flesh side, same time running through the jack in wet condition. Be sure and keep one split ahead of the machine. Hang up to dry them, take down and go over grain side same as flesh. The leather is now finished, and is ready to be measured and bundled for the market.

Degras.—Where we speak of degras in this chapter we, of course, mean that which is obtained in England and Germany from wool grease, not the French degras which is obtained from the oxidation of fish oil used in the tannage of chamois leather.

CHAPTER XXIX.

ENAMELED LEATHER, PATENT LEATHER, FURNITURE OR UPHOLSTERING LEATHER, REGALIA LEATHER.

ENAMELED leather is grained or pebbled so as to give it a broken surface. Patent leather has a smooth glossy surface.

The steer hides employed for the production of enameled and patent leather to be used for carriage tops, and also those employed for furniture or upholstering leathers, are the largest and finest slaughter hides that can be obtained, practically free from blemishes. The largest and best hides are selected from those which are purchased in the markets of Chicago, Kansas City, St. Louis and Omaha. Hides which measure six feet eight inches across the brisket and over are taken. Cow hides which measure six feet four inches across the brisket and over are taken for trimmings and furniture leathers. Large bull hides, measuring six feet four inches across the brisket, are used for patent collar leather, and smaller size for shoe tippings.

Sometimes during a scarcity of hides they are imported from France, Germany, Switzerland and other countries, and Anglo-American hides are brought from England; the latter hides being those of animals which have been exported from America to England and slaughtered there.

The soaking, unhairing and fleshing of the hides is the same as has been described for other varieties of leather. The liming is longer, usually for ten days. If the limes are heated, as some tanners employ them, they remain for a shorter time, and are then struck on the beam to work out the lime. Then they go into the bate of pigeon or hen manure, which by some tanners is heated to about 100° F., where they remain for five

or six hours, care being observed to handle them up five or six times during this period. Some tanners use a cold bate, in which the hides are allowed to remain for about twenty-four hours. They then go on the beam and are worked over very carefully with a bate stone. When they have been properly worked with the bate stone and while they are still on the beam, they are further worked with a steel worker in order to free the hides from lime and dirt as much as is possible. They are then placed in a perforated wash wheel and washed. The wash wheel is put in motion and a two-inch stream of cold water run continuously on the hides until the water coming from the wheel shows no signs of lime. The time consumed in this washing varies, and depends upon the quantity of lime and dirt which is in the hides when they are thrown into the wheel. Hides treated in this manner will go into the liquors, practically speaking, perfectly free from lime and grit, which will prepare them better for splitting as the sand and dirt which may have been collected in the flesh will have been removed by the washing in the wheel. This washing may be done in two or three minutes, or the time required may be longer, depending upon circumstances. As soon as the water runs clear from the wheel, the washing is complete and the motion of the wheel should be stopped. This washing is a very important step in the manufacture of enameled or patent leather, or of any other grade of leather, as hides treated in this way do not carry any lime or dirt into the liquors, and the liquors thereby become more effective. If this washing is not done, it will be necessary to place the hides in a weak sour liquor containing almost no tannin, so as to neutralize the lime that may be left in the hide.

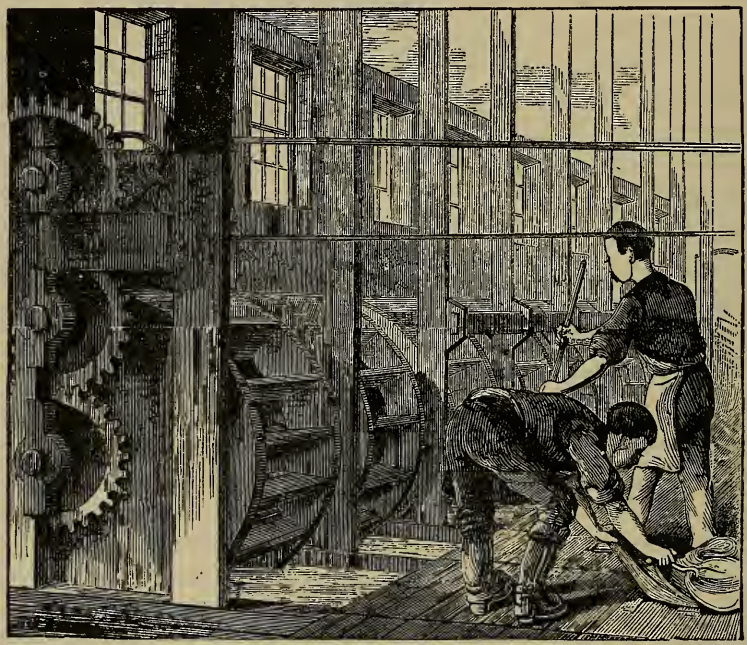
Care should be taken not to allow the wash wheel to run for too long a time, as it would result in making a loose and spongy flank.

After they have been properly washed the hides are in condition to go into the "handlers" or "rockers" to be properly swelled for the reception of the tanning liquor.

The tanning vats used in some tanneries are shown in Fig. 116.

The material employed by some tanners for tanning the hides is a mixture of oak and hemlock bark, making what is known as "union tannage." Some tanners use vats having a circular bottom, and above which there is placed a revolving wheel which agitates both the tanning liquor and the hides;

FIG. 116.



TANNING VATS IN PATENT LEATHER FACTORY.

there being usually a number of these vats placed in a line, as shown in Fig. 116. The wheels are worked for about fifteen minutes in each hour. Other tanners use "rockers" where the hides are stretched out and hung on hooks, the hides being rocked three or four times a day. They remain in the rockers for about twelve days, the time depending upon the strength of the liquor, etc., the longer they hang the plumper and firmer the leather will be. They are then taken out and put in a large

power press, and the surplus liquor pressed out. They are then hung up and partially dried or "sammied" to prepare them for the splitting machines. These machines are known as the "Belt Knife" and "Union."

When the hides are in proper condition they are split from three to four times, three times being the average. 1st, the buffing is taken off, which is used for hat sweats, pocket books, book bindings, etc. 2d, shoe tippings, upholstering leather, carriage tops, etc. 3d, comes the middle split, which is used for soft dash or hard dash, and if a very heavy hide, a flat split or "junior winker" used by harness makers, is taken; fancy splits, enamel splits, inner sole, bag leather, shoe splits, collar leather and for various other purposes. 4th, comes a slab which is used by trunk makers and collar makers. If it is very light, it can only be used by trunk makers; if heavy, by collar makers. 5th splits are very rare, unless the people are making very light splits, and light splits as a rule have very little strength on account of having very little fibre.

The hides and splits after leaving the splitting machines are re-tanned in japonica, gambier, hemlock, quebracho, canaigre, etc., as circumstances demand. They remain in the re-tanning process from about three to ten days, the time varying in different tanneries, depending upon whether the tanner uses warm or cold liquors and how well the hides are tanned before splitting. The tanner may sometimes be rushed with his "handlers" or "rockers," thus forcing the hides to be split in a greener state. In such cases it will be necessary to give the hides a longer time in the re-tanning. About three days for hides and about ten days for splits is the usual time in cold liquors, depending upon the kind of leather which it is desired to produce. Warm liquors run from 95° to 100° F., cold liquors from 75° F. down. The re-tanning is done in boxes which measure seven feet and six inches long, by five feet wide, by three feet six inches deep inside. There are trays set over the boxes on one side to hold the hides and splits as they are handled out of the liquor each day.

The heavy leathers, such as flap, etc., require longer time, say about fifty days, and are twice laid away, the first layer being for about twenty-four days, and the second for about twenty-six days. This treatment, however, is arbitrary. The hides remain in the last layer until wanted, it may be for three or six months, depending upon the demand for the leather. It is a good place to preserve the hides if the tanner has plenty of spare vats and little storage room.

Then the hides and splits are placed in sumac liquor and remain for one day; about one-half pound of sumac being used for each hide. The amount of sumac employed varies, however, with the practice in various tanneries. Some tanners use a refined extract of sumac which takes the place of the ground sumac leaves, saving the tanners the time of leaching, also saving the loss that often occurs from souring liquors.

The hides and splits are next scoured by hand on a table, which accomplishes two things, *i. e.*, 1st, the removal of the excess of tanning material, dirt, etc.; 2d, the setting out. Then they are stuffed with various mixtures of cod oil, degras, linseed oil, etc. It is dangerous to use either cod oil or degras unless a strictly pure article can be had, as a poor quality of cod oil or degras made from it will cause the leather to gum on the surface and to stick together and stain in spots. If there be any question about the quality of the cod oil and degras, it will be better to use only either raw or boiled linseed oil.

A stuffing which has been found to be very satisfactory in practice is made as follows:

Dry white lead	30 pounds.
Litharge	30 pounds.
Raw linseed oil	50 gallons.

The dry white lead and litharge are each mixed with about ten gallons of raw linseed oil, and these two mixtures of twenty gallons are poured into the kettle and thoroughly stirred before it goes upon the fire. The stirring is done with the idea of preventing the white lead and litharge from settling in the

bottom of the kettle. This mixture of white lead, litharge and linseed oil is boiled together for six or eight hours and carried to about 400° F., or until it is reduced to the consistency of syrup. The mixture when cold is reduced with naphtha, say fifty gallons of naphtha to fifty gallons of oil, or it can be reduced to any required body and applied to the hides or splits.

After they come from the scouring and stuffing tables, the pieces, hides, splits and buffings are tacked on stretching frames and stretched, and allowed to become thoroughly dry.

A good frame for stretching leather is shown in Figs. 117 to 121, and is the invention of Charles P. Oliver and Theodore P. Howell, of Newark, N. J.

This device possesses the merit of unusual simplicity and cheapness of construction, and also is susceptible of operation without removing the frame from its pendent position from the supporting-bars.

Fig. 117 is a representation of a top view of Oliver and Howell's Machine. Fig. 118 is a vertical transverse section of the same. Figs. 119, 120 and 121 are details of the same.

A represents the upper and *B* the lower cross-bar of the stretching-frame, and *C* indicates the sides. On the front sides of the bar *C*, or upon the sides of such bars, are affixed perforated plates, marked *a*. These perforated plates are adapted for use upon wooden upright bars; but in case such bars be made of metal, the plates may be dispensed with, and the cross-bars themselves be perforated. The cross-bar *A* is constructed with a rounded upper surface, to adapt it for holding the centre of the hide, inasmuch as this apparatus is designed for attaching both flanks or sides of the hide to the sliding bar *D*. The letter *D* represents the sliding or stretching bar, which is arranged with reference to the bars *A* and *C* in the manner shown. The letter *c* indicates the short arm of a joint attached to the sliding bar *D*, and *f* indicates the long arm thereof attached to the bar *B*, each connection being made with a suitable pivot-pin or hinge. These two arms of the joint are united by a tongue-and-groove joint, as shown in Fig.

118. It will be observed that the end of the sliding bar *D* is slotted to provide for holding the forearm of the joint and allow the movements thereof. The letter *y* indicates a quadrangular

FIG. 117.

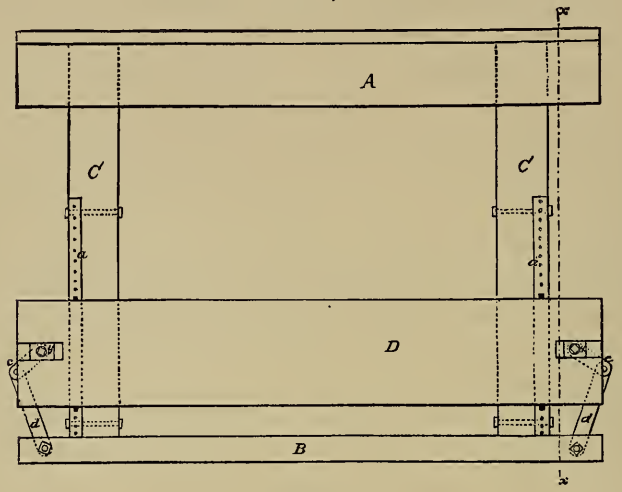


FIG. 118.

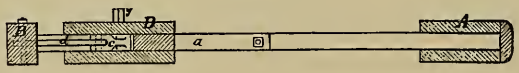


FIG. 119.

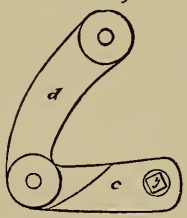


FIG. 120.

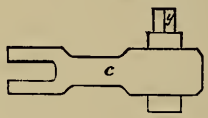
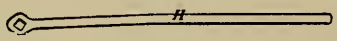


FIG. 121.



wrist firmly attached to the short arm of the joint. It is preferable to cast this arm and wrist in one piece of metal. The letter *H* represents a wrench, the head of which is adapted to fit upon the wrist *y*.

To operate this device, tack the moist hide to the sides of bar *D*, allowing the centre thereof to rest upon the oval upper surface of bar *A*, and place the wrench head upon the wrist *y*. Then turn the wrench downward, bringing the two arms of the joint toward or beyond a right angle, thereby increasing the distance between the bars *A* and *D*. When the skin is sufficiently stretched, place a pin above the bar *D* in one of the apertures of the perforated plate, and permit the skin to dry, or be manipulated, as the operator may see fit.

The dry room is heated by steam and a ventilating fan draws off the moisture; the drying usually requiring two or three days. The hides and splits are then taken from the stretching frame and are passed through a pin-block machine, to give them a preliminary softening, and are next taken to the table and boarded by hand to complete the softening. The softening table is covered with a split, which is tacked on in the wet state so as to dry even and taut.

After the hides, splits and buffings are softened they go to the "patcher," whose business it is to patch up the pieces by the putting on of a patch with glue to prevent the enamel composition which is later on to be applied from running through and staining the under-side of the piece. Then the hides, splits and buffings go to the table of the sorter, who classifies them into the different grades as to quality, size and substance. The buffings are graded as to the degree of imperfections, such as horn scratches, rough grain brands, grub holes, salt stains and substance, making about five selections. The buffings are further graded as to the manner in which they split, viz., the "Belt Knife" and "Union." The "Belt-Knife" buffings have the head and butt on them. The "Union" buffings have either the head or butt missing. The hides are divided into two classes, hand-buffed and machine-buffed. The hand-buffed hides bring the best price, as the buffing is sacrificed and only the best hides are selected for this class.

The hand-buffed hides make the following grades, viz.: grain dash, landau, calache, top hides, upholstering, trimming, shoe enamel, shoe tipping and binding leather.

The machine-buffed hides make the following grades, viz.: grain dash, top hides, upholstering, trimming and binding leather.

The splits make the following kinds of leather, viz.: skirting, hard dash, soft dash, black and fancy enameled splits.

The buffings which have been selected for japanning are divided into three classes; the best grade going into enameled buffings, the next grade into fancy colored buffings, and the last grade into patent or black buffings. The buffings which are not required for japanning are sold in the russet for making stained buffings, which are used for book bindings, pocket-books, ladies' hand-bags, etc.

The hides, splits and buffings which have been selected for enameling are next toggled, stretched and tacked on a frame with ten-ounce tacks. The hide frames are about nine feet by ten and one-half feet outside measurements, and are made of seven-eighths inch stuff, four and one-half inches wide. The split frames are about nine by nine feet, made of the same material. For japanning side leather the frames are about four and one-half feet by nine feet, made of one and one-quarter inch stuff, five inches wide.

BLACK ENAMELED TOP LEATHER SUCH AS IS USED FOR BUGGY AND CARRIAGE TOPS.

The hides next receive a heavy coat of daub, which is made of raw linseed oil boiled to a jelly. The boiling usually requires about twenty-four hours, which time includes about five hours allowed for the addition of naphtha, which is hereafter described. The time is usually spread over two days, twelve hours being consumed each day. The kettle in which the oil is boiled should be twice the capacity of the oil to be boiled at one time. The kettle should be portable and mounted upon a truck, so as to wheel it off the fire when the temperature becomes too high. There should be a lug or flange for holding thermometer in kettle. The boiling is done over a coke fire similar to the fires in use in an ordinary varnish factory. The

oil is continually stirred from start to finish with an iron paddle about eight feet long, or of any suitable size, with holes made through the paddle portion, which is about three-sixteenths of an inch thick, to prevent the throwing of the oil out of the kettle.

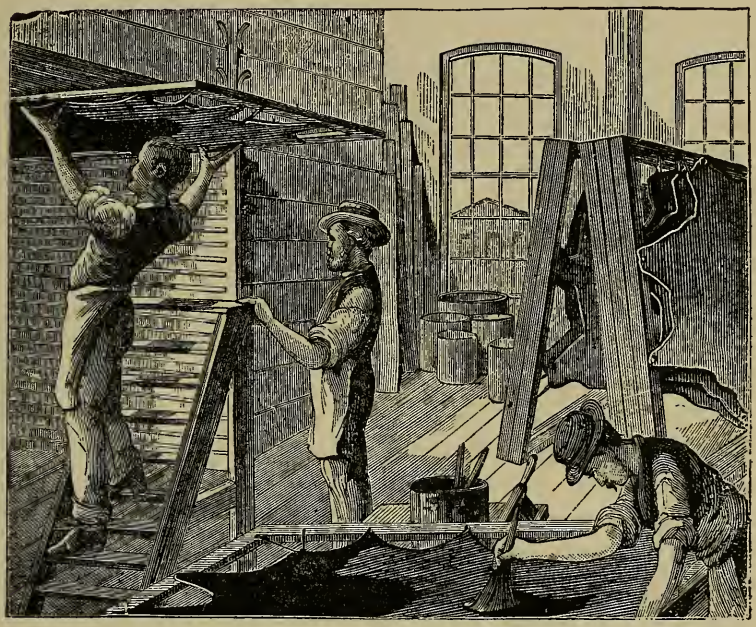
The oil is carried gradually to about 580° F. the first twelve hours, and is then lowered to about 400° F. before leaving work for the day. The next day the temperature of the oil is again gradually increased to from 580° F. to 610° F., depending upon the nature of the oil, the weather, etc. Some oils will cook with less heat than others. When the oil is cooked to the consistency of a jelly on the second day, it is taken off the fire and cooled down to about 400° F., and naphtha is added in the proportion of one and one-third gallons of naphtha to the gallon of oil. Say we are boiling seventy-five gallons of oil and it is ready to receive the naphtha; the naphtha is added, twenty-five gallons, to reduce the temperature of the oil, which is slowly stirred in, and when this twenty-five gallons has disappeared, twenty-five gallons more of naphtha are added, under constant stirring, so as to break up the composition and allow the naphtha to penetrate it, and this is continued until about one hundred gallons of naphtha are added, only twenty-five gallons at a time being put in. The more rapidly the naphtha is added and the composition stirred, the better. The fire used for cooking the oil must be put out, every spark of it, before the naphtha is added. The brick-work of the furnace is flooded with water, so as to prevent the gas which comes from the naphtha from striking the hot bricks and thereby causing an explosion of all the naphtha. When you desire to make a foundation for a dark color, such as black enamel, soft dash, hard dash and black buffings, add one pound of lamp-black of the best quality free from grease to four gallons of the composition just described, which is known technically as "sweet-meats." It does not take the name of daub until the lamp-black is put in.

The lamp-black is added under constant stirring. In large

works, such as the American Oak Leather Company of Cincinnati, Ohio, the stirring is done in a mill built for the purpose, which holds about sixty gallons. It has two upright pieces of iron or blades bolted to the bottom and extending to the top of the mill. The dasher which revolves at the top of the mill has four blades bolted to it on one side and two blades on the other, so arranged that the upright blades pass between the revolving blades. The mill has an opening at the bottom through which the daub is drawn. The mill is driven by power and makes about sixty revolutions a minute. The daub is ready to apply to the leather as soon as it comes from the mill. This daub is applied to the hide as a filler and is put on with a steel slicker, the blade of which measures ten and one-half inches long by two and five-eighths inches deep, and nearly one-eighth of an inch thick, having rounded corners and a knitting-needle edge. The daub must be worked in thoroughly and the excess scraped off with a slicker, care being observed in the scraping not to scratch the hide. The hide is then exposed to the sunshine or air until the daub coat is thoroughly dry. When dry the hide is given a second coat of the same composition. Usually the second coat is put on the next day, and it is then run into the oven (see Fig. 122) to dry, remaining from ten to twelve hours at a temperature of from 110° F. to 120° F. The hide then receives a slicker coat, which is linseed oil boiled to about the consistency of New Orleans molasses. This slicker coat is put on with a smaller and thinner slicker than that used for the daub, and is a scant one-sixteenth of an inch in thickness. After the slicker coat is dry, which usually requires about twelve hours in the oven, it is rubbed with a flat piece of pumice stone to make a smooth surface. The hides next receive a coat of enameled varnish, which is made of linseed oil and Chinese blue, boiled down to the same consistency as the slicker varnish. It is boiled for about eight hours, and is gradually carried to about 560° F., being stirred all the time. This varnish is reduced with naphtha. After the first coat of varnish is put on, the hide is again placed in the oven and thoroughly

dried, which usually requires about ten hours. It is then taken out and pumiced, and receives the final or finishing coat, and is again placed in the oven and dried at about 140° F. The hide is next exposed to the sun and air to remove the sticky surface. The length of exposure varies, running from three to ten hours. The hide is then taken from the frame, and hung in a damp

FIG. 122.



DRYING OVEN IN PATENT LEATHER FACTORY.

room for twenty-four hours, and allowed to regain the natural moisture lost in the japanning process. The edges are then trimmed to remove the tack marks, toggle holes and varnish. It is then boarded by hand to raise the grain after which it is measured, and is ready for the market.

SMOOTH FINISHED PATENT LEATHER.

The split receives three coats of daub. The last coat of daub when dry is pumiced. Then it receives a coat of black

varnish, which when dry is also pumiced. The second coat of black varnish is then put on and dried, and after the drying is completed this coat of varnish is again pumiced. The daub used for splits is nearly the same as for the hides, but the boiling of the oil does not require so long a time, about twenty hours being sufficient.

The black varnish is made of linseed oil and raw umber boiled from eight to ten hours at a temperature of from 500° to 580° F. being stirred continually. The cooking is known to be done or finished when a sample of the varnish taken from the pot and cooled can be stretched into a thread between the thumb and first finger. When the varnish is boiled to this stage it is taken off the fire and cooled down to about 350° F., and lamp-black of the best quality, free from grease, is gradually added under careful and continuous stirring until it becomes one body. The lamp-black is added in the proportion of about one-fourth pound to a gallon of oil, measured before boiling. This black varnish is then reduced with naphtha until it will flow freely under the brush, usually about one and one-fourth gallons of naphtha to one gallon of the raw linseed oil measured before boiling. The split next receives three coats of finishing varnish as follows: The first coat is flowed on with a brush and dried in the oven at about 170° F. for from ten to fifteen hours, or until it is thoroughly dry; care being always observed not to get it too dry. It is pumiced and receives the second coat of varnish, which is again dried at about 170° F. for ten to fifteen hours, the same care being observed as in the first drying. It is then very lightly pumiced with a very fine, smooth stone. It is then perfectly cleansed of all dirt, dust and grit. The split, in fact, receives two cleansings: 1st, the dry dusting, which is done with a dry sweep; 2nd, the cleansing, which is done with a wet sweep.

The split is now ready for the final coat of varnish, which is flowed on very carefully, and is then put in the oven and dried at a temperature of about 170° F. and remains usually for about

forty-eight hours, judgment being used as to the degree of heat, which is intended to bake or unite all the compositions applied to one body. The finishing varnish, three coats of which are applied, is made of linseed oil and Chinese blue. From two to six ounces of Chinese blue is added to the gallon of oil, and this is boiled to about the consistency of the black varnish. The composition is stirred continually and is boiled for eight or ten hours. The composition should cook at 580° F. It should then be dipped over into a reducing pan, which must be outside of the boiling-room, and is allowed to cool over night. The next day it is reduced or thinned with one gallon of naphtha to each gallon of oil. The naphtha is added gradually under constant and continual stirring. This varnish is stored in a room which has about 70° F. for its temperature, and remains for about six weeks before using. After the split has been exposed to the heat of the oven for about forty-eight hours, it is taken out and cut off the frame, trimmed and measured ready for the market.

PLAIN BLACK BUFFINGS.

The buffing receives one coat of black daub the same as the hide, two coats of black varnish and two coats of finishing varnish. The drying must be done at about one-third less temperature than for splits. Care should be taken not to dry too much. The buffing should be exposed to the sun or air on the finishing coat. It is then cut from the frame, trimmed and measured ready for the market.

FURNITURE OR UPHOLSTERING LEATHER.

The finishing of furniture leather for the first three coats of daub is the same as for black enameled top leather previously described. Then it is painted of any desired shade. The number of coats depends upon the shade required. Furniture leather is not varnished. It is dried at about 120° F. The colors can either be bought ground in oil or dry, the grinding being done under your own supervision and with oil especially purchased for the purpose.

REGALIA LEATHER.

Regalia leather is made from about the same selection of hides as is the furniture and upholstering leather. The usual colors are red, white, blue, orange, lemon and maroon, but any color that is desired can be produced. Regalia leather receives the same number of coats as furniture or upholstering leather, and is dried in the oven at about the same temperature. But this daub has no lamp-black in it; it is in fact the "sweet-meats" already referred to reduced to the substance of daub. It is pumiced on the last daub coat, and it receives as many coats of color as are necessary to produce the shade desired. The colors are mixed with a fine clear varnish, free from gum; but the last coat is clear varnish. Care should be used to purchase the very best colors that are made. Buy them dried, and grind them in oil yourself. The oil used is what is called the clarified boiled linseed oil. We have the formula of a varnish which is used for making regalia leather and all delicate colors. This varnish is free from gum, and leather coated with it will not break or stick. It is the most valuable varnish for the purpose which we have ever seen. We are not at liberty, however, to make public the formula of this varnish, as there are other parties interested with us in its ownership.

NOTES.

The finishing room should be kept clear of dirt of all kinds. There should be no draft. Ventilation should be through the roof. No rags and no clothes should be allowed in the room. The men when finishing wear no clothes except trousers and shoes.

Naphtha is used as a reducing agent for the compositions instead of turpentine, because it is cheaper, costing only about one-sixth as much.

Compositions which are intended to be aged are, however, better produced with turpentine, as naphtha will evaporate too quickly.

The thermometer used for boiling the oil can be bought from

the Hohmann & Mann Manufacturing Co., Plymouth and Jay Streets, Brooklyn, N. Y.

The sweep and the round varnish brush used for flowing on both the black varnish and the finishing varnish, which is a seven-inch Russia bristle, and the flat brush used for painting furniture leather, can be purchased from Dixon & Ripple, Newark, N. J. The slickers can be bought from Richardson, Newark, N. J. H. L. Pope & Co., Dayton, Ohio, make a good grade of linseed oil by the old process, which is much used for manufacturing enameled and patent leather.

A GOOD WAY TO OPEN ENAMELED AND PATENT LEATHER WHICH IS STUCK TOGETHER.

Put the leather out on the grass before sunrise, while the dew is on the grass. Let it lie until the sun warms it through, and then strip it. This method, of course, can only be used in warm weather.

PRESERVING THE GLOSS ON PATENT LEATHER.

The following is a French recipe for preserving the gloss of patent leather: Melt pure wax over a water-bath, place on a moderate coal fire, add first some olive oil, then some lard, and mix intimately by stirring; next add some oil of turpentine, and finally some oil of lavender, fill the resulting paste into boxes, where, on solidifying, the necessary consistency will be acquired. To restore the gloss to the leather apply a little of the paste and rub with a linen rag. This will keep the leather soft and prevent cracking.

RENEWING THE SURFACE OF JAPANNED LEATHER.

In 1863 Wm. Hoey patented in England the following compound for renewing the surface of japanned leather: Two ounces of paraffin, or rock oil, or a mixture of both in any proportion, to which are added one-quarter of a drachm of oil of lavender, one-quarter of a drachm of citronel essence, and one-half ounce of spirits of ammonia. The mixture is applied lightly to the surface of the leather.

PREPARING THE CUT SURFACE OF SPLIT LEATHER FOR MANUFACTURING JAPANNED OR ENAMELED LEATHER.

The common way of buffing the hide or preparing it for japanning or enameling is either by shaving off the inequalities with a currying-knife, or by taking off a light buffing with the regular splitting machine. This light buffing, when finished, is of little value, bringing from one to three dollars. The way japanned or enameled leather is often treated is by applying all the coats of the composition to the leather after being tanned, and when perfectly dry on the frames. The naphtha or turpentine in the composition is then absorbed by the dry leather, and it becomes dry and harsh; but by applying the first coat of the composition when the leather is wet and the pores are filled with tan-ooze, the naphtha or turpentine evaporates before the leather becomes dry, and is not absorbed by it, and the leather is left soft and flexible and more easily worked.

If a heavy buffing be taken off, it leaves the surface fibrous and coarse, and it is necessary to have a smooth surface to finish on—that is, to japan or enamel.

Stephen J. Patterson, of Bridgeport, Conn., in 1883 patented the following method for forming an artificial grain on the hide after it has been buffed or split with a regular splitting machine.

This process of treatment applies equally well to light buffings or splits, but is especially adapted to heavy ones by largely increasing their value.

Patterson's improvement is as follows: When the split hide comes from the tan-liquor after the tanning operation is completed, it is slicked out on a table and a light coat of oil spread over the surface with a sponge or soft brush. Then it is tacked on a frame, and while still wet the fibre or nap of the freshly-cut surface is brushed down smooth in one direction with a flexible bristle brush (like a shoe-blacking brush, but larger), which simply gives direction to the fibre or nap; and then there is applied, while the hide is still wet, with the same brush or with a sponge, rubbing in the same direction, a coat of com-

position made from linseed oil boiled down to a jelly and reduced with naphtha or turpentine to the proper consistency. After this application repeat the brushing operation as before. The hide is now left to dry, and when dry the composition holds the fibre or nap in place, and the leather has a smooth surface to japan or enamel. When dry it is finished the same as other japanned or enameled leather. The hide is not dubbed with a mixture of cod oil and tallow or other grease, as in the ordinary method of preparing heavy leather. For shoes and harness only a light coat of oil is applied as stated. It is buffed or split with the splitting-machine when about one-third tanned.

For treatment by this process, Mr. Patterson takes off a heavy buffing with the largest size improved "Union Splitting-Machine," making a buffing about three-fourths the size of the hide. This is thick enough to japan for shoe leather or similar purposes, and will bring from four to eight dollars when finished. The extra expense will not exceed one per cent. of the cost of the hide.

JAPANNED LEATHER IN IMITATION OF ALLIGATOR SKIN.

The object of this process, which was patented by Franklin S. Merritt, of Boston, Mass., in 1871, is to produce japanned leather in imitation of alligator skin.

The leather is prepared by the ordinary process of currying for patent or enameled leather. Afterward it is coated with a composition of linseed oil boiled with driers, viz., litharge, burnt or raw umber, sugar of lead, sulphate of zinc, Prussian or Chinese blue, mixed with naphtha, benzine, spirits of turpentine, or camphine, with sufficient lamp or ivory-black to give it coloring.

The leather, after being coated with several layers of the composition, each being dried before the next is applied, is rubbed with pumice-stone to give a smooth surface to the coating. Finally the last layer is applied and dried without rubbing with pumice-stone, the whole making, thus far, what is usually

called "patent or enameled leather." The leather in this state is next wet sufficiently to soften it to admit of its receiving and retaining the impression of the die or rollers. Next the sheet of leather is passed between rollers or dies, or compressed by the same, so as to emboss it with the required figure or series of convexities. Next it should be softened while wet by "boarding," or by any other mode of effecting such as usually adopted by leather dressers, and then dried.

FIG. 123.

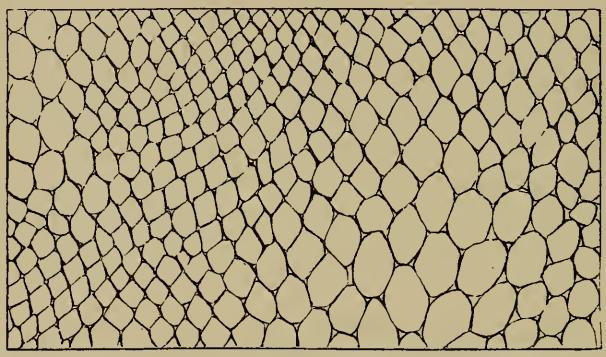


FIG. 124.

Figure 123 represents a face view, and Figure 124 a section of a piece of leather made as described.

When finished it may be used for many purposes in the arts, particularly in the manufacture of hand-satchels, shoes, etc.

LINSEED OIL.

Linseed oil, which enters so largely into the "sweet-meats," and daub for enameled and patent leather, is obtained from seeds of *Linum usitatissimum* (Linn). They contain 30 to 35 per cent. of oil, 26 per cent. of which can be obtained.

	Winter Flax.	Spring Flax.
Oil	35.20 per cent.	31.60 per cent.
Organic Substance*	53.00 "	57.40 "
Ash	3.15 "	3.20 "
Water	8.65 "	7.80 "
	100.00 per cent.	100.00 per cent.
* Protein substance therein	22.10 "	24.00 "

The oil is obtained by either of the three following processes:

Cold Drawn Oil.—The seeds are crushed, ground or bruised, and expressed without heat. This is considered the best oil, and in Russia and some parts of Germany is used as a table oil and for baking. By this process the seeds yield from 20 to 21 per cent. of oil.

Ordinary Linseed Oil.—It is prepared in the same manner as above, but with the assistance of heat, which gives it a disagreeable taste. The yield is from 27 to 28 per cent. It is used for technical purposes.

By Extraction.—With a yield of 32 to 33 per cent. Seeds two to six months old are generally used, as the oil expressed from fresh seeds is viscous and turbid. The cold-drawn oil is golden yellow, and has a peculiar but not disagreeable taste and odor. The hot pressed oil is amber-colored or brown-yellow, and has an acrid taste, due to traces of volatile fatty acids, such as butyric, valerianic and caproic acids.

Linseed oil is somewhat thickly fluid, and, as it belongs to the drying oils, very quickly absorbs oxygen from the air, becomes lighter in color, rancid, finally entirely thickly fluid, and dries. Its specific gravity is 0.9375 at 50° F.; 0.9463 at 53.5° F.; 0.9350 at 59° F.; 0.9325 at 68° F.; and 0.9300 at 77° F. At 59° F., the oil is 9.7 times more thickly fluid than water; and at 45.5° F., 11.5 times. At a decreasing temperature, it becomes gradually thicker, becoming pale and turbid with increasing cold, and congeals to a solid yellow mass at 16.5° F. At 266° F., it commences to boil, and after boiling for some time at 482° to 554° F., until it has lost about one-

twelfth of its weight, it becomes thicker, viscous and sticky, and furnishes varnishes. By heating it still further, until it has lost one-sixth of its weight, it becomes still thicker, the product being printers' ink. By heating linseed oil to 608° to 707° F., it ignites and burns quickly without further external heating, until tar and carbon remain. By interrupting the burning by covering the boiler, there remains a brown, turpentine-like substance, the so-called bird lime. Linseed oil is soluble in 1.5 parts of ether, in forty parts of ninety per cent. spirits of wine, in five parts of absolute alcohol. It is miscible in all proportions with chloroform, oil of turpentine, bisulphide of carbon, etc. Its elementary composition is:

	Cold Drawn.	Hot Pressed.
Carbon	78.11 per cent.	75.27 per cent.
Hydrogen	10.96 "	10.80 "
Oxygen	10.93 "	13.85 "
	100.00 per cent.	100.00 per cent.

Linseed oil is a mixture of linolein, the glyceride of linoleic acid, which forms the principal constituent, about eighty per cent., olein, palmitin and myristic acids. Nitric acid, of 1.30 specific gravity, colors linseed oil sulphur yellow, and if the acid contains some nitrous acid, yellow-greenish, which, however, soon changes to red-brownish. Fuming nitric acid produces on the point of contact a red-brown zone, while the acid itself is colored green. By shaking the mixture becomes dirty cherry-brown, which later on becomes somewhat paler. Sulphuric acid causes first a green color, which, however, soon changes to brown. By mixing ten drops of linseed oil with three drops sulphuric acid, a red-brown resinous mass is formed. A mixture of sulphuric and nitric acids produces, first, a yellow color, which changes to gray-green, and, later on, to a dirty green-brown.

Five parts, by weight, of linseed oil, causes the temperature to increase from 59° F. to 194° F., a difference of 134°. The temperature of linseed oil adulterated with colza oil rises only—

With	5	per cent. of colza oil,	to	163.5° F.
"	10	" "	"	160.0° F.
"	15	" "	"	157.0° F.
"	20	" "	"	153.0° F.
"	25	" "	"	150.0° F.
"	30	" "	"	146.5° F.

Solution of nitrate of silver causes a somewhat red-brown coloring. Zinc chloride produces no effect. Ammonia, potash lye and lime water produce yellowish liniments. Caustic alkalies saponify linseed oil very quickly, yielding soaps of little solidity. By saponification, linseed oil gives ninety-five per cent. of fatty acids and five per cent. of glycerine. The above-mentioned formation of a brown resinous mass, by mixing ten drops of linseed oil with three drops of sulphuric acid, is very characteristic as regards adulterations. In the presence of foreign oils, such as colza, poppy seed, nut, cotton-seed oil, etc., the oil does not form a brown, viscous resinous mass. The linseed oil alone is changed to a resin, the brown resinous flakes floating in the admixed oils. An admixture of fish oils is readily recognized by their peculiar odor and taste, or by phosphoric acid, of the consistency of syrup, which colors linseed oil yellow-brown, but fish oils red, which is, however, soon changed to black-brown. Even Scotch cod-liver oil, which is now brought into commerce almost inodorous and of a very pale color, shows this change with phosphoric acid. An adulteration with even $\frac{1}{100}$ per cent. of fish oil can also be detected by the red color produced by sulphuric acid. Concentrated hydrochloric acid added to linseed oil gives a yellow mixture. If hemp oil be present, the mixture is yellow-green, because hydrochloric acid mixed with hemp oil gives a characteristic grass-green color. An addition of resin (colophony, etc.) is recognized by the white, lumpy precipitate which is formed by shaking the linseed oil with spirits of wine, and compounding the alcoholic solution with alcoholic solution of sugar of lead.

Linseed oil is extensively used in the manufacture of paints, printing ink, varnishes, and in the finishing of enameled and

patent leather, leather dressing, etc., and for the preparation of water-proof stuffs, floor cloths, elastic rollers, etc. Linseed oil boiled to the consistency of caoutchouc served formerly for the manufacture of bougies, catheters and elastic probes. To prepare such caoutchouc mass, the linseed oil is brought to a very thick consistency by boiling for at least twenty-four hours, and is then boiled a few hours longer with diluted nitric acid. The mass is plastic, and becomes hard on contact with the air. By dipping in hot water it regains its softness, and on cooling solidifies again to a caoutchouc-like mass.

Linseed oil is sold under four different forms, viz.: raw, refined, boiled and artists' oil. Of these, by far the most important, commercially speaking, is the boiled. The selection of the oil to be boiled is a matter of the utmost consequence to the oil boiler and varnish maker, since the beauty and durability of the paints mixed with it depend largely upon its quality. If the seed be not fully ripe the oil expressed abounds in mucilage, water and pulpy matter, while more or less acid is also present. If, on the other hand, the seed be full grown and ripe, the oil is limpid, pale colored and of a highly refractory power. To summarize the chemical changes induced in linseed oil by exposure to the air, it may be said that the oil dries, or, in other words, that it passes, by mere absorption of oxygen from the atmosphere, from a fluid to a solid state. From this known property was derived the theory that it was necessary to heat with certain metallic acids from which the oils might derive oxygen previous to its exposure to the air, thus shortening the time subsequently needed for complete absorption. Various oxides were made use of for this purpose; plumbic oxide (litharge), red lead and anhydrous binoxide of manganese. More recently the last two named oxides have been employed conjointly, and to these agents have been added lead oxide or plumbic acetate, zinc sulphate, etc. The occasional addition of umber serves only to deepen the color of the oil.

The reasons for boiling linseed oil are principally two: First, that drying may be facilitated when the oil is spread upon thin surfaces, either alone or mixed with paints. The second, that it may serve as a vehicle for the mechanical suspension of the finely divided particles constituting a paint, thus enabling them to adhere to the surface on which they are spread.

It must not run into drops, nor must it leave the coloring matter behind; the color must be carried by it, evenly diffused over the whole surface over which the paint is laid. The object to be obtained is to secure a coating impervious alike to liquids and gases. It may sometimes happen that even when the process of boiling has been performed properly, and with the utmost care, the result may prove unsatisfactory to the consumer. This may somtimes be traced to circumstances entirely independent of the process of manufacture. The quality of the seed, green or ripe, new or old, the climate, and the soil in which the seed was grown—all of these exert a marked influence upon the product. The different varieties of seed call for separate and distinctive treatment. All oil boilers should test the drying qualities of each batch of oil.

One tried and approved test is to dip into the oil, when cool, a piece of well-sized paper, which is afterwards hung up to dry. Thoroughly well boiled oil will produce a crystalline surface over nearly the entire portion of the sheet dipped in the oil. If the boiling has been imperfect, the upper portion of the paper's surface will simply be greasy, and only the lower portion will show the varnished coating. When the touch of a finger to the submerged portion of the paper shows no grease adhering to it, the boiling may be said to be complete. Reference has already been made to the use of heat for the purpose of driving off the mucilage from the seed, The philosophy of the process consists in the throwing off of the water (probably held by the mucilage) a yellow froth mounting to the surface of the gradually heating oil. The continued application of the heat evolves numerous gases. Before the attainment of the result hoped for from the heat, however, a temperature of between

600° and 700° F. has been obtained. When the partially destructive distillation has effected the desired change in the oil, the liquid assumes a deep, permanent (sometimes reddish) brown.

In the opinion of some manufacturers, the depth of this brown is the best test by which to gauge the thoroughness of the boiling. The old-fashioned way of fire heating has been to a very considerable extent abandoned, steam being employed as a substitute.

CHAPTER XXX.

HORSE LEATHER.

THE manufacture of horse hides for footwear originated in Denmark, and from there it followed the coast of the Iberian peninsula, and was largely developed in Hamburg. There it took root immediately and was developed gradually to the highest degree of perfection.

From Hamburg the art spread to Austria, Poland, the Russo-German provinces and Scandinavia, which have each manufactured some very handsome horse leather footwear.

England and France are also manufacturing this leather to some extent; but in the United States there is but little done in this line of manufacture. At the Philadelphia Exhibition in 1876 all other kinds of leather produced in this country were exhibited, horse leather being the only exception.

The proper method of liming and working out these hides in the beam-house is the foundation for a good finished product. The tanning of horse hides is not generally understood in this country, simply because the work in the beam-house is not properly comprehended. It is conceded by all that in the vicinity of Hamburg and Bremen and in Holstein, the tanners are experts in turning out horse butts. These are limed differently from any other raw material. The hides are soaked three or four days, according to the time of year. They are fleshed the second day in soak. After that, put them in a very foul lime. If it is not foul enough to suit, add hen manure to the lime, so that the hides will be very slippery on the flesh side. This makes them very flacculent, so a deep impression can be made with the finger. As soon as the hairs are loose, put the hides in a strong lime made with fresh water; for every 15

butts three gallons of unslaked lime. After slaking, the lime is allowed to cool off thoroughly. The hides are then handled immediately, and for three days twice a day. This strong lime swells them up greatly, thereby loosening the so-called "spiegel." The unhairing is next done, and the flesh shaved off the butts thoroughly. They are then bated in hen manure. They are required to be so slippery on the grain side that it would be difficult to hold them, and the dirt is thoroughly worked out of them. Stamping in warm water is the next process. The butts are put in fresh water over night and in a very light oak liquor.

The usual time which the sides remain in the handling liquors is six or seven days, and they are then laid away twice in ground bark, both lay-aways extending through about seven weeks.

Upon being removed from the second lay-away the sides are hung on poles and exposed to the open air to harden, and are then dampened and split, but the operation of splitting horse hides by machinery is much more difficult than that for other species of hides, and requires considerable experience.

In Hamburg, Germany, where a large quantity of horse leather is manufactured, the splitting machine is not employed, the custom being to soak, unhair and flesh the hides, and then to cut the butt at once by taking off a few thicknesses with the fleshing knife.

The sides split by the splitting machine are next flattened by having their shanks and bellies leveled off with a currier's knife.

From this point the process of tanning and currying horse leather is the same as has been described for the side of upper leather.

Horse leather is also finished in imitation of kangaroo and other grains.

Cordovan.—Horse hides for shoe purposes usually have the butt or shell cut out in the tanyard; they come into the currier's hands with the hind shank left on. The first process is

to soak them down, after which the mane is cut out, the shanks removed and the hides split down the back. They are then slicked. We find the best way is to slick them well on the flesh side; it extends the hide more, and less weight is taken off. Generally they are shaved over when they are in sides; the bellies are then cut off, so that the only beam work required is to level the thick parts for cordovan. With regard to the soaking, we find that sumac liquor is preferable to water; it improves them, and does not wash out the tan. After shaving, the hide should be scoured on both flesh and grain side, taking care not to "fur" or break the grain. There is generally a great deal of "bloom" or dirt, gathered from the tan, that must be carefully cleaned from the grain. By doing this, the grain becomes open and the leather softer, allowing it to absorb as much as possible of the sumac liquor, commonly called "compo" in the trade. After scouring they are placed in the "compo" and well handled once or twice a day. Every time they are handled they should be laid up for an hour or two before being again placed in the "compo." If they are well tanned, two or three days is quite sufficient for them to lie in it. The liquor should be warmed every day. When finally taken out of the liquor they are slicked out, either on the flesh or grain side; the flesh is better, as it leaves the "compo" in the grain. After hanging in shed, in order to stiffen a little, they are taken down and set on the grain side, which should be well oiled and as much dubbin put on the flesh side as the substance and quality of the leather will carry.

They are then re-hung in the shed until quite dry. They should lie a few days in the grease before blacking (called in the trade seasoning). The blacking should be done on the grain side, and if the grain is in any way damaged they should be first buffed with a turned slicker or knife. When the black has well gone into the grain, bottom size and hang them up to harden. Then dubbin them again and lay them by for a day or two, taking care that they do not get dry. Afterward set them off on the flesh and on the grain with a dull slicker, and hang

them in a good warm stove to dry off. The flesh side is then cleaned, the grain is slicked with a dull slicker and some dubbin rubbed in. After laying by for a few days the grease is slicked off, the finishing size put on, and the cordovan is ready for sale. With regard to the "compoing" where a drum is not used, the best way is to put it in large tubs or vats and well handle the hides.

One of the most notable and distinguished achievements in the production of chrome leather, which deserves to be chronicled, is in the making of a wax finish on chrome-tanned horse hide butts (cordovan) and on calf skins. This has been accomplished by Hahn & Stumpf, of Harrison, N. J., who use the Dennis one bath system of chrome tanning. The firm also make a chrome tanned horse hide front, with a kangaroo finish, which is certain to find favor with shoe manufacturers. The chrome tanned and wax finished cordovan goloshes and calfskins are, however, a distinct and important advance in the art of leather making, and young Henry Stumpf is deserving of much credit for his ingenuity in accomplishing this result. The writer has seen this leather, and is well convinced that it is superior to the old style of bark tanned wax leather. Messrs. Hahn & Stumpf will undoubtedly secure a large and increasing trade among shoe manufacturers with their new line of chrome tanned leather.

Many horse hides are bought and sold in Hamburg, Germany, where dealers say that if Americans made a more thorough selection there would be a great increase in their purchases of horse hides. Mule and horse hides should be separated. Mules are unknown in Germany. Horse hides should be classified into primes, seconds and thirds, and into sizes.

Horse Hides for Enamel.—These are generally split down the back, the shank removed and dressed in sides. They are shaved very level, scoured on flesh and grain, put into some good sumac and well handled for a day, then taken out and slightly slicked off on the flesh. Some linseed oil is then put on them and they are put in the shed, hanging them as wide

apart as they possibly can be to get stiffened. When fit to take down set them well on the flesh and the grain, and roll them with a straight or cross-grained roller; hang them in the shed to dry; when dry take them down, stone well on the flesh, whiten them over the beam or with a turned slicker, then bruise on the flesh and slightly run the grain up. They are then ready to be enameled.

Horse Hides for Plain Enamel.—Are dressed in the same manner as grain enamel, with the exception that they are buffed all over on the grain, and are generally shaved much thinner than the grain; they also are not rolled or printed; when dry they should be whitened. After being well stoned on the buffed side, as well as bruised on the flesh, they are ready to be enameled.

Horse Hides for Memel.—Some are dressed in sides, others without the bellies on, and the butt pieces cut off and dressed for cordovan, but the bellies and shanks are sometimes put on for memel. They are shaved, scoured and "compoed," slicked out of compo on the flesh, then hung up in the shed to samm or stiffen. When sufficiently stiff, they are set and printed on the grain, then stuffed on the flesh and hung up to dry. When dry, they are seasoned and bottom sized and a little oil put on the grain. When a little stiffened, they should be grained up so as to make the print of the roller show up well. Then put them in the hot room or shed to get thoroughly dry. The flesh must then be cleansed. Raise the grain again, oil them off and they are fit for sale, to be cut up for shoes or any other purpose.

CHAPTER XXXI.

ALLIGATOR LEATHER.

A FASHIONABLE material for small valises, satchels, portemonnaies, cigar cases, etc., is the skin of the alligator, and in addition to uses enumerated it has also been employed for uppers of men's and women's shoes.

In all the Gulf States, from Florida to Texas, these saurians are hunted to supply the demand.

Alligator leather has been in vogue for a long time, but during the past fifteen years the slaughter of the alligator has been prosecuted with great activity.

R. W. Smiley and B. M. Gopelrivitch, special agents of the Census Bureau, completed a tour of the bayou district of Louisiana, having traveled over 1,000 miles through the network of bayous, lakes and bays. Among the subjects investigated by them was that of alligator hunting, formerly an industry of no little importance in Louisiana, giving employment to several hundred men and furnishing a large amount of leather quite popular in the manufacture of shoes, trunks, bags, etc. This industry, which reached its height about ten years ago, is reported to be nearly dead, confined to a very few bayous and lakes, the saurian population of the state having been destroyed by the hunters.

The alligators now killed are much smaller than formerly. There are stories of saurians of the past forty feet in length, but they are probably apocryphal, and from twelve to sixteen feet will represent the largest of late years. They have now dwindled down to barely half this size, and are so scarce that one can travel an entire day through the swamps without seeing one, and a great majority of the people in Southern Louis-

iana have never encountered a wild one. There are very few breeding alligators left, and the saurian will probably be extinct in the State in the next ten years, except a few tame ones kept in the parks.

Notwithstanding the reports to the contrary, the alligators were rather innocent animals. Occasionally they stole young pigs, and there is a tradition that they had a weakness for pickaninnies, but there are not over half a dozen cases recorded of people being hurt by them, and they seemed thoroughly indisposed to attack man. They succeeded, however, in keeping the streams of the State nearly destitute of fish, and the fishing will probably improve with their destruction, now so imminent.

Brazil is now our chief source of supply for alligator skins, which are only of fair quality.

These skins are usually packed for shipment in barrels and are green salted. The salting is often poorly done, and if the skins are allowed to remain too long in the barrels they become heated and the grain sides thereby so injured that they have to be finished into second-class leather.

Only the skin from the belly and sides is used; the back with its heavy coat of scales is cut out and thrown away as worthless.

All the skins show great uniformity, being of a bluish black hue on the sides and a peculiar bluish white under the belly, and each skin is curiously checkered in oblong divisions, which being separated by intersecting grooves, and wrinkled, give the peculiar appearance seen in all alligator leather.

The trade in these skins receives them of all sizes from three feet up, the average prices paid at New Orleans, La., ranging from fifteen cents each for the smallest to about one dollar for the largest. The skins most in demand are about seven feet long. Those of the monster alligators ranging from ten to fifteen feet long are not much desired. Under the continual destruction of alligators the supply is rapidly diminishing, and it is now but a question of a few years when it will be impossible to obtain these skins at a price that will justify their general employment.

To supply the demand for cheap articles, imitation alligator leather is now being largely produced.

The alligator leather of this country and the kangaroo leather of Australia are similar in the respects that they both depend upon wild animals to supply the material for their manufacture, and the business is therefore to some extent precarious.

At the place of shipment, the skins from young, middle-aged, and old alligators are thrown promiscuously into barrels, and the first step when they arrive at the tannery is to assort the small and medium-sized from the larger ones, which are kept separate.

The skins are then thrown into vats containing clear, cold water, and in these soaks the smaller ones remain about two days and the large ones four days.

They next go into vats of lime, which should not be so strong as for depilating, and remain from eight to fourteen days, according to size.

Each day the skins are reeled into stronger lime, great care being observed not to rot the tender portion during this swelling.

The bate of hen manure, into which they next pass, is made quite weak, and in this bate the skins are gently agitated by means of the usual England wheel, the period for which they remain being from ten to fifteen hours, according to size.

They are next cleansed in a wash wheel and then thrown into a vat containing hemlock liquor of about 4° strength, and every other day are shifted into stronger liquor, until at the end of about twenty days it has been increased to about 20° strength.

A gentle agitation of the tanning liquor during the last twelve days is very beneficial, as it aids in the more thorough tanning of the skins, and prevents the settlement of the sediment of the liquor into the creases, which is liable to rot the tender portions, especially those of young alligators.

After being subjected to the tanning process just described, the skins are hung in the open air to harden. They are then

carried into the finishing room, and eight or ten skins are piled one upon the top of another and placed in a clamp, the flesh side being uppermost. The flesh sides are then softened by the operator with a tool, the object being to throw up the rougher portions, which are then lightly cut off with a currier's knife.

If the skins are intended to be manufactured into upper leather they are again placed in the tanning liquor of 8° or 10° strength, and in this they remain for six or eight days, during which period they are gently agitated.

After being removed from the final tanning liquor the skins are scoured by hand on a slate table, first on the flesh and next on the grain side, the tools used being the scouring brush, stone and slicker.

After being scoured they are placed in the air to harden, and when not quite dry they are carried into the shop and stuffed by hand, tallow, fish oil and a small quantity of rosin being used.

They are next "set out" and are then carried to the finishing room and blackened on the grain side with a preparation of logwood and copperas.

They are next glassed by hand, and if a gloss is desired they are "pasted over the black" and hung up in the finishing room to dry over night.

In the morning the skins are re-glassed and immediately finished by gumming them over on the grain side with a preparation of gum tragacanth, and are then measured and ready for market.

The skins not intended for the manufacture of upper leather are not blacked, but are finished in their natural color, which is a yellowish-brown, and are used for satchels, pocketbooks, etc.

CHAPTER XXXII.

RUSSIA CALF.

To make colored or Russia calf, get as good a selection of green skins as possible, and free from salt rust. Soak in packs of convenient size, and so that the skins in each pack are not too widely different in weight. The number of skins in a pack should be controlled by the size of the soaks, limes, and tan vats. The following quantities of green skins will make convenient soaks in paddle vats of 700 gallons, with good inflow of water, during time of soaking. We would say 400 five-pound skins, 300 six-pounds, 250 eight-pounds, 200 ten-pounds, and 150 twelve to fifteen pounds.

Trim and soak ten to sixteen hours, according to season of year and necessity of hurry. About ten hours' soaking in the summer is usually sufficient for ordinary stock. Dry skins should be milled five hours or more after soaking so as to soften properly and be in good condition for the limes. It is very important that skins be fairly well broken in the hide mill, or they will cause trouble. Make up limes 60 parts of lime and 35 parts of sulphide of sodium. Both materials to be dissolved in a barrel of warm water before putting in the vat. Swab each skin before putting in the vat, by dipping flesh in a box of large size containing solution of sulphide and lime in same proportion as in vat. As each skin is transferred from swabbing box to vat they should be immersed by being shoved down with a pole. Haul on the following day and strengthen with same proportion of sulphide of lime. Put back and haul again on the fifth day, and strengthen, and the skins will be ready for unhairing on the eighth or tenth day.

From the limes or beam house the skins should go into a

rapidly revolving wheel pit, with constant inflow of water. Wash thoroughly three or four hours until water is clear and the skins free of lime. Then flesh on the machine and fine-hair the grain if possible. Leave in clear cold water over night or at least for five hours before bating. The lime and sulphide dissolve the hair completely and give a soft skin. The new bate can be made by using three bushels of hen-manure, or two bushels for renewing the old bate or pure. The liquors should be 90° F. Before putting back into bate, use wheel pit for this work and keep stock constantly in motion during this operation. After puring, rinse well and work on flesh side, then put skins into luke-warm water in tub before working well on grain. Then wash thoroughly in cold water and let the skins drain before putting them in tan vat. By this method of depleting, packs can be thoroughly reduced in three hours and then worked so that they can be put in tan the same day.

In tanning use wheel pits of convenient and uniform size, each containing about 700 gallons of liquor. Divide tan-room into three divisions. First—Sufficient vats for handling and coloring. Second—Vats for continuing tanning from the striking liquors to the time of skiving. Third—Vats for tanning out stock after skiving.

Liquors should be four to five degrees barkometer. Into the water pits should be put six or seven pails of gambier liquor standing 75 degrees in the pails; also four or five pails of sediment gambier after the boiling. When the liquor is ready, immerse the stock and run the paddle wheel 30 to 40 minutes to assure a good, uniform color on grain. Strengthen twice daily with two or three pails gambier and sediment, morning and evening, and run wheel three times daily, ten to fifteen minutes each time. Continue in this manner four or five days. Then haul packs and strike out flesh on machine. Now transfer to the second and stronger liquors of eight or ten degrees. Hold packs in this liquor for 14 days, moving them around in the vats by running the wheel three times daily from eight to ten minutes each time, and strengthen with two or three pails of gambier, meas-

uring 75 degrees, in the pails. This should be done once daily for 14 days, when stock will be about struck through. Withdraw and set out on flesh by machine. Then skive and put back in third section of finishing liquors of 12 to 15 degrees for seven days. Strengthen each day with two pails of gambier, and run wheel each time 10 to 15 minutes. This wheeling or turning over of the packs hastens the tanning and changes the position of each skin in the vat, thus assuring a uniform color on grain. By using one pail of salt per vat each week the liquor will be kept sweet and the tanning done more rapidly. Striking or coloring liquors should be run down the sewer after each pack is removed, as such liquor is dirty and worthless after a week's use.

After the stock is tanned out, it may be strengthened and cleared by running in drum with seven pounds alum and five pounds salt to every 125 skins. Use seven pails of water for dissolving this material. After running for thirty minutes, horse the leather for five hours, so as to drain well. Then oil in drum, using five quarts neatsfoot oil to every 125 skins. Keep drum turning thirty minutes in oil. Then stop, withdraw the pack and use machine for setting out flesh. Then hang in loft to dry.

As the majority of Russia tanned skins need cleansing before shaving to the desired substance required by the tanner, it is necessary to remove the excess of tan or other surplus matter by washing in a mill, using twenty pails of water to each 125 skins. The water should be 70° F., and the stock run in it 15 or 20 minutes—no longer. From the drum, set out on flesh side on machine. Then oil on grain by hand with neatsfoot oil, and dry out in moderately warm room.

After the stock is dried, wet down and horse up; drain five hours before shaving. After shaving, fat-liquor as follows: To each 60 skins use two gallons of fat liquor and one pint of birch oil well beaten into the fat liquor. Run the stock 30 minutes, and then set out on flesh by machine and grain by hand. Use glass on grain; then put on hooks to dry slowly. When dry

take down to color, using 100 pounds of dry leather to each batch colored. Give each of the 100-pound batches seven pails water, 90° F., in drum to wet up stock before coloring. Run stock 25 minutes. Drain off any excess of water not taken up by the leather. Throw stock well up on each side of the door of drum, so that no skin will lie in dye before starting the drum in coloring. Boil up dyes with one pail water, and add six pails water of 80° F. to stock in mill; then add dyes and start mill immediately. Run stock twenty minutes in dyes and to each change of dyes.

After coloring and before removing from mill, drain off any excess of dye and apply egg, using one pint of egg-yolk to each dozen skins. Run stock in egg for fifteen minutes; then horse up from mill and put on hooks to dry. When dry, lay in sawdust to dampen for staking. Stake well on machine; then trim, and, if stock requires it, use three gallons of fat liquor in six pails of warm water. In wetting down stock to set out, the latter should be done carefully on flesh and grain. Then dry out and brush on grain with powder brushes. Season and pack down four or five hours before rolling. Roll hard and air off in warm room. Stake light on grain and roll light. Then measure the stock, which will then be ready for shipping away.

ANOTHER PROCESS FOR COLORING.

After shaving skins to uniform substance for the work in hand, fat-liquor and set out on flesh by machine, and grain by hand. Dry cut; then take 100 pounds dry leather in one batch for coloring. Put stock in drum with twenty-five gallons water of 90° F. Run stock fifteen minutes in water, then drain off any excess of water not taken up by stock in drum. Bail up dyes in one pail water. Give stock in drum six pails water of 80° F., and add dyes. Use the same amount of water to each change of dyes and run stock twenty minutes in each change of dyes.

After coloring, rinse in clear water and egg, giving a proportion of two egg yolks to each skin colored.

Color No. 2 is composed of the following dyes:

1st Dye.	*2d Dye.*
8 ozs. Acid Brown N.	86 ozs. Nankin.
4 ozs. Orange D.	¾ oz. Methyline O.
	6½ ozs. Bismarck Brown R.

Color No. 3: 1st dye—15 ozs. acid yellow, F.; 2d dye—1¼ ozs. Bismarck Brown R: 15 ozs. aniline yellow.

Color No. 4 is made up as follows:

1st Dye.	*2d Dye.*
40 ozs. Bronze No. 2.	84 ozs. Nankin.
13 ozs. Acid Brown N.	32 ozs. Bismarck Brown R.
18 ozs. Orange D.	22 ozs. Leather Brown No. 2.

After coloring, dry out in room of 80° to 90° F. When dry put in sawdust and dampen to stake. Stake well, then wet down to set out. Set flesh on machine and grain by hand. Dry out in moderately warm room. When dry, brush with power brush on grain, then season, using seven quarts vinette and whites of two eggs in two and one-half gallons water. Use flannel pad to apply seasoning. After seasoning, pack down grain to grain. Let lie four hours. Then roll hard, air off in warm room. Stake lightly on grain. Roll lightly and stock is ready for shipping room. For the above description we are indebted to Hide & Leather, of Chicago.

CHAPTER XXXIII.

THE MANUFACTURE OF RUSSIA LEATHER—RUSSIAN METHOD OF PREPARING AND APPLYING THE MORDANT AND DYE—MANUFACTURE OF BIRCH OIL.

THE MANUFACTURE OF RUSSIA LEATHER.

In Russia a variety of leather is made called *Juften*, or incorrectly *Juchten* (Russia leather). It is a well-tanned leather of unusual strength, great flexibility and almost impervious to water. Moreover, it is not attacked by insects, because it possesses a penetrating odor very disagreeable to them, but so acceptable to many men that they perfume their linen with pieces of the leather, or carry pocket books, cigar cases, or the like, made from it.

Russia leather attracts a great deal of attention on account of its peculiar odor, and in other countries frequent attempts have been made to impart a similar odor to other kinds of leather.

Russia leather is employed more for articles of luxury than of utility, and does not moulder under the influence of dampness.

But its use for book-binding in the numerous public libraries of this country is being rapidly superseded by red-colored Morocco leather, which is attractive, more durable, and less costly.

Russia leather is also much used in the manufacture of jewelry cases, handkerchief cases, and other toilet articles, also for albums, traveling bags, etc.

It derives its name from the country whence it originated, and where it is more especially manufactured.

It is a fact now established that tanners of other countries

are well able to produce an article very similar and very much cheaper than real Russia leather, but, however, minus its fine odor. In a paper published on the manufacture of leather in Russia, written by two officials in the Russian War Office, the peculiar odor imparted to the leather was attributed to the tar extracted from the birch tree. After the Exhibition at Philadelphia, a company of American leather manufacturers purchased 200,000 puds of the oil (1 pud = 36 pounds), but the results obtained with it were anything but satisfactory. The price of this birch-tar oil varies from 3 to 4 roubles per pud; the oil, however, is so much adulterated that Russian leather manufacturers, as a rule, are provided with means of their own for its preparation, and in Germany an essence is made by Dr. C. Heintzel, of Luneburg, which gives to leather an odor very nearly approaching to that of Russia leather.

The Russia leather manufactories are situated mostly in the districts of Viatka, Orel, Iver, and Kasan, where are numerous birch forests. Here the hides of young cows are especially used for the manufacture of Russia leather—white, red, and black. The raw or wet hides, in order to deprive them of hair and flesh, are laid in lime or ashes mixed with lime, and they are kept there until the hair begins to loosen. After the unhairing, the hides are placed in the vats for swelling, then washed in running water, cut, salted, placed in a receptacle containing a mixture of flour and warm water and shaken and turned about vigorously. By this means a fermentation is set up, and the acid thereby produced takes away the last remains of the lime. This is the oldest mode of operation and the one most in vogue, but in some tanneries the process varies.

The tanning should begin with the placing of the hides in the pits, and with their treatment in weak liquor, and there are four shifts which last over 20 or 25 days. About 46 pounds of bark are used on an average for each hide. After being rinsed and sorted, the hides, being still damp, though not wet, are spread, grain-side downwards, upon a table, and smeared with a mixture of birch-tar and melted fat. Every hide intended

for white or red leather receives in this way one-half pound of tar and one pound of fat. The mixture is put on carefully with the hand so as to be perfectly smooth and equal. When this is done the hides are hung out in an open shed to dry. Those intended for red leather are smeared in drying with a solution of alum, and the grain side of each hide treated with sandalwood dye put on cold. Those intended for black leather are rubbed on the grain side first with a solution of alum, and next with a solution of logwood put on almost boiling hot, and then, to set the color, brushed over with a solution of green vitriol (sulphate of iron). In some cases, instead of the vitriol a liquor is used which is obtained by putting old rusty iron into an acid decoction gone into a fermentation and called by the workmen "quass." The hides are then once more rubbed over on the flesh side with birch-tar and melted fat in the proportion of one-half pound to each hide. If, however, the production of the so-called birch-tar leather is aimed at, one and a half pounds of each substance is taken.

As a final preparation the leather is softened in water and thoroughly worked upon the tree, smoothed and kneaded, and afterwards rubbed briskly with the graining tool, and lastly with a tool of glass, stone, or steel on the grain side, alternately rolled, and greased a little on the grain side. The black leather is also smeared on the grain side with a mixture of birch-tar and fat.

In other processes of tanning, the hides after being unhaired and fleshed are piled up with alternate layers of ground willow bark in great vats, and then covered with a solution of willow bark. They are moved from ten to six times in the tan pit, and the spent bark is each time replaced with fresh, until the tanning is completed. In Russia the hides of cows or young bullocks are employed by preference, and horse hides are also used, especially in the interior of Russia. In France, however, these hides are hardly employed at all, but only the skins of rams, goats and calves. This is done because the French Russia leather is principally used in book-binding or for cover-

ing cases and similar work, for which that made in Russia is entirely unsuitable, in the first place because it is much too coarse, secondly, because it is so permeated with fat as to render it undesirable for the purposes mentioned.

In the preliminary preparation for tanning, it is essential that the hides be entirely freed from lime. The Russians employ a peculiar process for this purpose, which is, however, as the result shows, very effective. They swell the hides for several days in an acid bath composed of rye and oatmeal and water, to which a sufficient quantity of leaven is added to set up fermentation in the whole mass.

After this operation has been completed, the hides are tanned first in oak tan, then in willow, and finally to remove their stiffness are softened in a flour pap. This is composed of about a pound of rye flour for each hide, and ten pounds of salt to each four hundred hides. After they have laid in this mixture several days, they are washed off, dried lightly, and then greased with a mixture of two parts of train oil and one of birch oil. Of this mixture about half a pound is used for each cow or horse hide. It is well rubbed in upon the flesh side with the flat hand, and left for some days to take full effect, which is generally secured by hanging the hides under an airy shed. This completes the process as it is generally carried on with them.

Russia leather is also manufactured in Austria, where it is tanned with tan-bark. Austrian tanners do not understand the art of bringing out the natural grain, so they give their Russia leather an artificial grain, produced by lines which intersect each other at acute angles, thus forming rhomboidal lozenges. The false Russia leather may be at once recognized by this regular artificial grain, which the Russians never produce.

In order to obtain the birch oil the Russians proceed just as the Polish peasants do in the preparation of their pine-tar. If they are especially careful, they do not dig a pit in the ground, in which to place the wood to be distilled, but employ two large pots. The two pots are filled with the cork-bark of the

birch, each one having a little opening in the bottom, by which ventilation is possible. The sides of the pots, which are placed one above the other, are smeared with clay. The bark in the under pot is ignited through the opening, this is placed upon another empty pot, and the whole is left to itself. In the bottom pot there collects considerable tar, quite a quantity of impure wood-acid (pyroligneous acid), and upon this floats the clear birch oil. This process may be called the rational one, but the customary way is to dig a pit in the ground, cover the sides with clay, and dig a ditch at the bottom of the pit, in which is placed a cask or barrel to receive the tar and other products of distillation. The pit is then filled with birch bark, which is piled up in the shape of a mound. This is covered with sod, in which at various places air holes are made, to permit the exit of the smoke and the entrance of air. Although both processes are very crude and yield only poor results, they suffice for the needs of the uncleared Russian forests, where raw material costs nothing. In America, if birch tar or oil is desired, it is secured by dry distillation, by heat applied from the outside, whereby everything that is in the wood is saved, and all that is left in the vessel in which the distilling is done is good charcoal.

The birch oil, which is lighter than water, transparent and moderately volatile, is mixed with train oil in varying proportions, from one part train to two of birch oil or the exact reverse. This latter oil is called in Russian *daggeat*. If the green buds and young twigs of the birch be distilled by themselves, they give an agreeable oil smelling something like rose oil. This the French claim to use for the preparation of the finer sorts of Russia leather. Since, however, these do not smell in the least like rose oil, either the claim concerning the oil, or the statement that it is used in their preparation, or both, are untrue. In fact, there are many different claims made concerning the manufacture of Russia leather; this is partly due to the actual employment of varying processes, partly to the fact that the travelers from whom the information comes, not

being skilled in the craft, either understand what is told them incorrectly, or actually receive false information. This last happens especially with uncultivated people, who having only a meagre industry, are especially jealous of it, and do not willingly give information concerning it to strangers.

The red color of Russia leather is caused by a surface dyeing with sandal-wood or Guinea red-wood or Sanders wood. After the hides are tanned they are soaked in alum water, placed together two by two in a sack, and covered with the dyeing liquid. If the leather is desired to become black, sulphate of iron is added to the wood decoction. The greasing is always the conclusion of the process, and after the hides are placed on poles, about which they are wound many times, and stretched and pulled to give them the necessary flexibility.

The method of manufacturing this leather we shall now describe as it is conducted in the United States, for the reason that the machines here employed are so much superior to those used in Russia that an article almost equal to the native Russia leather is produced, and in a much shorter time.

The hides used in the production of this leather are generally cow or steer hides and large calf-skins, seldom goat or sheep-skins.

In tanning, the first operations, such as soaking, unhairing, fleshing, etc., are conducted in the same manner as for other kinds of leather.

The swelling of the hide is one of the essential points for its successful manufacture, and is proceeded with in the following manner: For one hundred cow or steer hides take twenty-two pounds of rye flour and ten pounds of oat flour, and knead with yeast and a little salt.

Allow this dough to ferment, and then thin with sufficient water to immerse the one hundred hides, which are left in this preparation for forty-eight hours, and when they are sufficiently swollen, the hides are placed in a tepid solution of willow and poplar barks. The hides are handled in this solution, twice a day, for at least eight days. They are next immersed in a

liquor, the tanning ingredients of which are composed equally of oak, pine, and willow barks, and in this liquor they must also be handled at least twice a day. After eight days the last-named liquor is renewed and the hides are hardened and split, and then again placed in the liquor for another eight days, care being observed to handle as before. After this time the hides are sufficiently tanned.

The period of tanning can be considerably shortened by using a revolving-wheel, placed over the tan-vat to gently agitate the liquor, such as the England wheel.

After being tanned the hides are cut into sides, and scoured and then rinsed in clear water and allowed to drip and dry. The sides are then slightly dampened and allowed to temper for two days and then greased with a mixture of birch oil and seal oil, two-thirds of the first and one-third of the second, according to the thickness of the leather.

For heavy leather a coat of this grease is applied to the grain side. The leather is then thoroughly greased on the flesh side, and afterwards fulled. The leather is next set out, then whitened, and finally boarded, and when well dried it is prepared for dyeing.

Before dyeing, the sides are submitted to an albuminous solution, which acts as a mordant to make the color penetrate more easily.

The leather is dyed black or red, but the latter color is most used.

The dye is made of a decoction of sandal or Sanders wood, the quantity of which must be judged by the operator, who obtains the correct shade by repeated essays on small fragments of leather.

Sandal or Sanders wood and cochineal give a richer color, and are sometimes used.

The leather must be dyed in several coats, taking care that the preceding one is well dried before applying another coat, the dye being applied with a brush to the grain side.

After dyeing, the leather is again impregnated with a mixture

of birch oil and seal oil, which must be made to penetrate as much as possible, by rubbing energetically with a flannel rag on the grain side.

As a mordant in Rùssia they use chloride of tin prepared in the following manner: Take 5⅔ ounces of nitric acid, heat it very slowly under a chimney having a good draft so as not to be affected by the emanations of the acid, pour in this hot solution, stirring it meanwhile with a glass or a wooden stick, 1 pound and 2 ounces of salt of tin. This operation must be done in the open air or under the influence of a strong draft, so as not to inhale the deleterious vapors of the nitric acid, which are excessively dangerous.

Stirring must be continued with caution so as to allow the unwholesome vapors to escape; when the mixture begins to whiten add 4½ ounces of fuming hydrochloric acid, stirring carefully for a few moments.

The liquor must be cooled and put in hermetically closed bottles, to be kept in a cool place, and before using this liquor it must be diluted in a volume of from 15 to 20 times its own weight of pure water.

The leather being prepared and cleansed from all foreign substances, the mordant is applied very briskly and uniformly with a brush.

As coloring matter in Russia they use 1 lb. 2 ozs. of sandal or Sanders wood boiled for an hour in 1⅝ gallons of pure water. This liquor is filtered and 1 ounce of prepared tartar and soda dissolved in it.

This mixture is boiled for an hour, and it is left standing for a few days before using, as it is then stronger.

The sides destined for black dyeing are only oiled on the flesh side, which must be dried with a woolen rag, leaving the grain half moist, and irreproachably neat.

The leather is submitted two or three times to the mordant, according to its thickness, and then dyed as many times with the warm dye, the temperature of which must be raised if necessary; *i. e.*, the dye must only be applied while warm, and if

the operation takes too much time according to the number of skins, the dye must be kept at the proper temperature.

The application of the mordant and dye is done with a brush by rapidly spreading the liquid which is poured on the leather.

Rapidity in this operation is necessary in order to spread the dye equally on the whole surface of the leather and to insure the same shade on all its parts.

The first coat of color is applied immediately after the mordant and while the leather still retains some of its moisture; the dye in this manner taking more easily and there being less risk of shading.

It is desirable for the good execution of this work to have two men operating together; the first applying the mordant, and the second the color immediately afterward. Should the color not be uniform another coat is applied at once with a lighter solution.

This red color lasts as long as the leather itself and does not damage it, whatever may be the time of its stay in the warehouse.

After the application of the dye the leather must be slightly moistened on the flesh side with some tan juice and dried, and then grained.

The red Russia leather acquires a brilliant appearance when its colored side has been coated with gum tragacanth solution by means of a sponge; this gelatinous water must neither be too thick nor be applied in too large a quantity.

For graining the hides the same methods are followed as for the manufacture of Morocco leather; but instead of being "straight grained" or "pebbled" the finish is a diamond-shaped grain.

A graining machine, especially for Russia leather, was invented by Towein, who, unfortunately, died when he was finishing it.

However, his work survives him, and his graining machine is in use in large French establishments and its success is complete.

Black colored Russia leather is prepared in the same manner as has been described, but is stained by the application of acetate of iron, aniline and other blacks being also used.

MANUFACTURE OF BIRCH OIL.

This oil is commonly called Russia oil, but, notwithstanding this name, the bark of the birch tree of all countries will produce it, and it is in the whitish, membranous epidermis of the bark that the oil exists, and this should be carefully separated from the ligneous or woody matter.

The bark is considered preferable when it has been freshly gathered.

If the distillation of the oil is done in the spring, some birch buds are mixed with the bark; a more limpid oil is thus obtained and its odor is more penetrating and delicate, resembling a little the flavor of the rose. This mixture also facilitates the separation of the oil, which when thus prepared is of a lighter color, from the very small quantity of soot it contains.

Many systems are followed to distill the birch oil; some of them, very simple, are within the capabilities of any one; the others, more elaborate, require the science and complicated stills of the chemist. This oil can be readily obtained by distilling the bark in iron cylinders placed horizontally in a furnace.

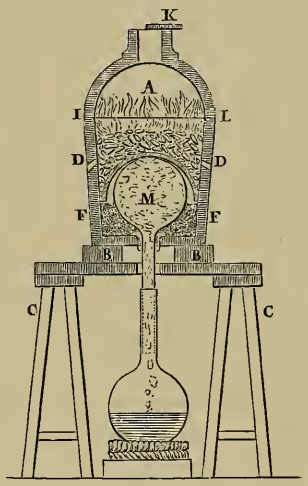
In each of the methods of distillation, to be hereafter described, separate the birch oil from the tar, acid, etc., underlying it, and keep it in a glass-stoppered bottle or some other close vessel.

The following is a simple method for distilling this oil: Above any kind of receiver place an earthen pot of a convenient capacity with a hole pierced through its bottom; fill the pot with the bark, put fire to the bark, and cover the earthen vessel with another of similar capacity, also having a hole in its bottom. The bark burns slowly, the smoke and the heterogeneous products of this kind of distillation evaporate through the aperture in the upper vessel, and the oil runs through the lower opening into the receiver below.

Another method, which is that of Fischerstroem, is a little different from this, although based on the same principles. To carry it out, fill an iron caldron with bark and cover with a convex lid, in the middle of which a hole is made, for the introduction of an iron tube; above this caldron another one is placed and the two secured together, the second caldron having a hole in the bottom, through which passes the iron tube of the first caldron, but which must not touch its bottom.

The two caldrons, suitably united, must be hermetically closed by means of clay. They are then inverted and half buried in the ground, the one containing the bark being uppermost, and it is daubed over with a mixture of sand and clay. A large wood fire is built around this iron caldron, so as to bring it to a white heat. When everything is cooled the distillation is complete and the caldrons may be opened.

FIG. 125.



In the upper caldron there will be a fine coal powder, and in the other the products of the distillation, *i. e.*, the birch oil floating, underlaid with a little tar, upon a slight layer of pyroligneous acid.

By Grouvelle and Duval-Duval's process, the material is introduced into a copper still, similar to those used to distill wood in the manufacture of acetic acid. The receiver is so adapted as to be immersed in water in which the gaseous products are condensed; and, as in the manufacture of acetic acid, the resulting products are pyroligneous acid, tar in larger quantity, and the oil more colored, and less abundant.

The oil may be obtained nearly colorless by rectification, but this is not necessary, unless the oil is intended to be employed on delicately colored leather.

By repeating the distillation *per descensum*, Payen ascertained that with a simple apparatus it is possible to obtain an oil less colored and in the proportion of one-fifth more, at a temperature less elevated.

To construct this apparatus, which is shown in Fig. 125, a hole is made in the bottom of an earthen furnace *A*, large enough to receive the neck of a matrass *M*. The furnace is supported by two bricks placed upon the plank, which is also perforated so as to admit of the passage of the neck of the matrass, and which rests upon the trestles *C*, *C*. The matrass is filled to its utmost capacity with the epidermis of birch bark; it is inverted and passed through the furnace and the board. Then the neck is luted and placed in the position seen in the figure, being supported by sand thrown into the bottom of the furnace as high as *F*, *F*, and in order to expose the matrass to a uniform heat, it is protected by inverting over it an earthen hemispherical vessel or crucible. Around this, burning coals are placed, and the fire is kept up through two lateral openings, *D*, *D*, the dome *I*, *K*, *L* being placed upon the furnace top. Condensed water first trickles from the mouth of the matrass into a vessel placed beneath, and this is succeeded by drops, and then by a constant stream of an amber-colored oil. After a time this ceases, and it is necessary to apply heat lower down to the neck of the matrass, so as to cause the discharge of the last portions of all tarry matters which have condensed in it.

The products obtained by the distillation of one hundred parts are as follows:

A brown, oily matter, light fluid empyreumatic, soluble in ether	70.00
Thick dark-brown tar, containing a little oil	5.00
Water acidulated with pyroligneous acid	10.00
Light spongy charcoal	12.50
Gases	2.50
	100.00

BIRCH OIL AND LEATHER.

Birch oil is obtained by dry distillation, and the process by which the Russian peasants effect the operation is the most

simple that can be imagined. A caldron capable of being hermetically closed, set in a brick fire-place above the ground, is connected, by means of a pipe, with another caldron buried in the ground. That is the whole of the apparatus. The upper apparatus is filled with dry birch bark, closed up, and then heated. The vapor which the enclosed bark gives off finds its way to the buried caldron, is there condensed, and becomes a dark-brown liquid. This is birch-tar. The tar is allowed to get quite cool, and during this process there rises to the surface a vegetable acid contained in the tar, which must be skimmed off. On the tar being distilled, an oil with a peculiar smell, something like that of cedar-wood, is formed, and it is this which imparts to Russia leather its peculiar odor.

Birch-tar, however, obtained in the way described, contains, besides the oil just alluded to, other oils, which possess a rather unpleasant empyreumatic smell. The raw birch oil of commerce, therefore, gives out this smell of burning to a very much greater extent than it does the pleasant smell, and persons not aware of this fact will not recognize birch oil as Russia oil, and will not risk applying it to their leather. These oils possessing this empyreumatic smell, however, are very volatile, and when the birch-tar is spread upon the leather they soon evaporate, merely from coming in contact with the air. When this is effected, only the pleasant-smelling oil remains, and the well-known grateful odor of the Russia leather is secured. It may be asked, "Why cannot the oils with the burning smell be removed without waiting for them to evaporate after being spread upon the leather?" It is possible to effect this by a special treatment, but as the process is a very costly one, and as only a relatively small quantity of the pure oil is obtainable from the birch-tar, the price of the pure oil would be very high. Birch oil is a thick and almost black fluid, and is consequently only suitable for the smearing of black leather. The oil distilled from it—birch-tar oil—is a thin liquid, and although not much lighter in color than the oil, it is transparent.

RUSSIA ODOR TO CALF LEATHER.

To impart the Russian odor to calf leather, the skins should be tanned in the ordinary way with oak bark, and then well washed and all the water got out of them, after which the grain surface should be lightly brushed over with a mixture made as follows: 60 per cent. of bright fish oil, and 40 per cent. of the thin liquid birch-tar oil. Let the skins then dry, and the desired object is attained.

BIRCH-TAR AND PINE-TAR—THEIR DIFFERENTIATION.

It is frequently very essential to know for a certainty the sources of tar. The subject has been investigated by Hirschsohn, who recommends the following process for the differentiation of birch-tar and fir-tar. At 68° F. birch-tar has a specific gravity of 0.925 to 0.945; while pine (fir) tar, at the same temperature, is 1.02 to 1.05; the one floating in water, while the other will sink if entirely freed of air. Birch-tar agitated with 10 volumes of water, abandons none of its coloring matter, though the water, while remaining perfectly colorless, acquires a markedly acid reaction. The addition of perchloride of iron to the water, produces a green color reaction. If 2 drops of anilin and 4 drops of hydrochloric acid be added to 5 ccm. of the water, a yellow color reaction results. If 1 volume of birch-tar be agitated with 20 volumes of petroleum-ether and filtered, a clear, brownish-yellow liquid is obtained, which does not become green when agitated with a diluted solution of copper acetate.

The aqueous extract of fir-tar is, on the contrary, colored a marked yellow, is of acid reaction, but becomes red on the addition of $FeCl_2$ (instead of green). Treated with anilin and HCl, the color passes to red. The petroleum solution, agitated with copper, becomes green. Finally, when pine (fir) tar and alcohol are agitated together, the former takes up no color. If there is any muddiness, or even cloudiness, you may be certain that the tar is contaminated with birch-tar, kerosene products, coal-tar, etc.

CHAPTER XXXIV.

WEIGHTING OF LEATHER.

No advances worthy of note have of late been made in the art of weighting leather. The same old methods are still in vogue, and apparently give full satisfaction. Weighting with sugar is by far the most common.

In testing leather which has been weighted with sugar, it is usual for the analyst to specify only the percentage of sugar or glucose found, and this particular percentage is then considered as indicating the artificially added weight. Recent analyses have, however, proved that this is no criterion.

The presence of sugar or other soluble matter is first of all indicated by the heavy shrinkage which occurs in washing out a sample of leather thus weighted. If the loss is insignificant or normal it may be taken for granted that the leather has not been tampered with. Artificial weighting is a tedious process, and the manufacturer employing such methods at all is sure to do his work thoroughly.

A sample of sole leather was recently analyzed which showed a washing-out shrinkage of no less than 16.8 per cent. So heavy a loss naturally presupposed the presence of artificial weighting matter in considerable proportions. Further analysis showed that only 5.73 per cent. of the matter thus lost was sugar, and that 10.3 per cent. of the total loss consisted of other matter, which is in itself a very high percentage for sole leather. The residue on being subjected to other tests to determine the presence of tanning matter, etc., developed so large a percentage of foreign non-tanning substance as to utterly preclude the possibility of the latter owing its origin in entirety to the tanning materials employed. The nature of the non-tanning

matter present could not be accurately determined, but it seemed to be of vegetable origin. The excessive presence of non-tanning matter may be attributed to the fact that in this instance, as in all probability is most often the case, the tanner had used molasses for weighting with, instead of a solution specially prepared by himself, the former being far cheaper, as well as handier. Molasses consists of about 50 per cent. sugar, 30 per cent. non-saccharine matter (organic and inorganic), and 20 per cent. water. According to this estimate, the presence of 5.7 per cent. of sugar, as in the instance referred to above, would represent a weighting with about 9.2 per cent. molasses (free from water).

This would leave of the 16.8 per cent. total shrinkage, a further loss of 7.6 per cent., or a figure just within the legitimate bounds of washing-out loss for sole leather.

We may thus conclude that, given the percentage of sugar in analyzing a weighted leather, if the washing-out loss still remains very high after deducting the former, the actual weighting can be fairly estimated at one and one-half times the weight of the sugar found.

CHAPTER XXXV.

TANNING AND DYEING FURS AND HAIR-SKINS.

THE hair is thicker in the autumn, and by beginning work at that time of the year the skins will be ready for market when the demand is at its best.

TANNING CALFSKINS.

In tanning calfskins in the hair, the tannin acts from the flesh side only and the hair will consequently be apt to slip until the tan reaches the hair follicles. All unnecessary handling should therefore be avoided, and the actual tanning be done as rapidly as possible, so as to give the hair no chance to fall out.

The skin must of course undergo a preliminary thorough cleansing, etc., and as the usual method of soaking, liming, etc., cannot be employed, the tanner must resort to special processes. Without some kind of preparation, the tanning would be a very slow operation and the skin be very apt to come out hard and tinny.

Only perfectly sound and fresh skins can, needless to say, be used. To remove all impurities the skins are first soaked in fresh, clear water as cold as the work admits of, and the water frequently changed. It is best to use covered vats—of stoneware or cement for preference, as these best retain the required low temperature. Soaking in running water is not to be recommended, as the action is less even and the skins are apt to accumulate slime and other impurities which make the hair slip.

After soaking one day, the skins are thoroughly worked on flesh side, to remove blood, superfluous flesh, etc. As this operation has to replace shaving, etc., it must be attended to very thoroughly, and specially heavy parts, as, for instance, the

pate, are either cut out or rolled to same thickness as rest of skin, which is an operation requiring some experience.

Next, place in fresh water, turning often; finally work and rinse again.

The skins are now ready for plumping. For this purpose they are soaked in a weak solution of sulphuric acid until sufficiently swelled (a cut will then show transparent instead of white). Then rinse again in fresh water and place in soda bath (5 to 6 pounds to enough water for 10 skins). This is done to reduce the swelling and to neutralize acidity. The soda is then removed by repeated rinsing and by finally being passed through water to which a little muriatic acid has been added.

Rinse for last time and place in water containing wheat flour 2¼ pounds per 105 quarts of clean water. This removes last trace of acidity and makes the skins soft and pliable. They are now ready for tanning.

As before stated, the tanning should be done as rapidly as possible. The strength of the tanning liquor is therefore gradually but not too slowly increased by adding extracts. As soon as the tan has taken hold thoroughly, a fairly strong liquor may be used, especially as in the case of skins tanned in the hair, a soft grain surface is of slight importance.

A mixture of hemlock and quebracho extracts may be recommended. Both make a soft tannage and supplement each other. The skins must be thoroughly tanned, or the grain is apt to be hard and peel off.

When thoroughly tanned, and not before, the skins are well fleshed to remove last particles of flesh, etc., which might interfere with the stuffing. The latter can, of course, only be done from the flesh side.

First, rinse well; wash the hair side thoroughly in warm soapsuds and dry in open air. The stuffing is applied warm and at frequent intervals. When the grease is completely absorbed, grain, stuff lightly again and dry out.

The skins are lastly slicked off, beaten and brushed out. The finish may be improved upon by waxing on flesh side.

FOR TANNING FURS, PELTRIES AND DEER SKINS.

(1) All skins, whether for furs, other peltries, or leather, must be thoroughly freed from flesh, fat and foreign materials. To do this beam with a knife, or scraper, and then scour well in suds of fine soap and sal soda, before any tan stuff or coloring matter is applied. Care should be exercised to see that the pelt is perfectly free from suds, by rinsing and wringing; also, by beaming previous to tanning.

(2) When the pelt is well cleaned and scoured, as above directed, make brine of common salt at blood heat until no more will dissolve. Then prepare a like quantity of mucilage, by passing very warm water through a fine sack filled with clean wheat bran. Also, dissolve a small quantity of good starch in warm water. Let the brine, mucilage and starch-water settle till quite clear, then pour them carefully together into a wooden or earthen vessel of sufficient dimensions to give free motion to the pelts when stirred. Place the vessel where it will keep warm for two hours.

(3) Dip the pelts in clean, strong alum water, at blood heat, for two hours; rinse the pelts free from the alum water, and wring or beam them as dry as possible.

(4) When all is ready, pour into a mixture of brine and mucilage (still keep warm). Add a quantity of sulphuric acid (oil of vitriol), two pounds of acid to ten gallons of water or mixture, and put the pelts in quickly, stirring them as briskly as possible for a few minutes. Take out the pelts, and scrape flesh as clean and dry as possible, putting back in same process for one hour. Be careful to have the mixture touch every part of each pelt.

(5) Let the pelts hang in a shady, airy place, until just dry enough to turn white when pulled or stretched in any direction. Continue the pulling and working of each pelt, changing the pelt round as it is pulled, to keep the fiber subject to an even effect. Much depends upon working the pelts at the right time; that is, when just dry enough to turn white when pulled, and by continuing the process of working until fully dry.

(6) When the pelts are quite dry they should be beamed over a beam, with a dull beaming knife, and finished by polishing the flesh side with coarse sandpaper.

IN THE PROCESS OF COLD TAN.

(1) Care should be taken to clean the pelts free from all foreign substances, after which place them in strong liquor made of alum and salt. This is to set the fur. Take out and beam well, then place in tan liquor made as above. Stir often. Thick skins, such as cow hides for robes, should remain from two to four days, according to thickness.

(2) All pelts should be cut down even with the currying knife before placing in tan. Furs, large and small, should be milled in sawdust. They are best handled in a fur worker run by power; this takes out all remaining oil left in the fur.

DYEING FUR SKINS.

Most tanners are no doubt at some time or other called upon to tan the skins of fur-bearing animals of the most diverse character, says the *Schuh und Leder* of Berlin. The actual tanning process is well-known to all, and the conscientious tanner fulfills this part of his commission to the best of his ability, although the result often leaves much to be desired. The main object, from his point of view, is to see that the hair is properly set, and this is usually accomplished by the use of alum; the appearance of the fur is often looked upon as a matter of secondary importance. By allowing the hair to retain its natural color, as is generally done, the commercial value of many varieties of peltry is less than it might be made if suitably dyed; in fact, in some instances, where skins from the same species of animal possess fur of totally different color, as they sometimes do, it is essential, in order to secure an even appearance, that the pelts should be dyed uniformly, thus enhancing their beauty and market value considerably, without in any manner detracting from the quality.

The dyeing of fur skins is a distinct branch of the furriers'

trade, and as the skin itself will not stand a heat of more than 104° F., the dyeing process is a very delicate operation, the trade secrets of which are more jealously guarded than those of almost any other. Where the whole skin is to be dyed, the dipping process is resorted to, while, where it is desired to color only the lighter portions, or to darken the tips of the hair, brushes are used to apply the mordant and coloring matter, the stiffness of the bristles used depending on the depth to which it is desired that the color shall penetrate. Suitable brushes are also used to produce stripes or other peculiar markings, and as coloring materials: burnt gallnuts, sulphate of iron, verdigris, sulphate of copper, etc. By means of these, all the shades of gray can be produced, as also a scale of tints, ranging from the lightest brown to the most intense shade of black.

Of late the manufacture of tar-colors, which has revolutionized the dyeing trade generally, has, in connection with the newly introduced so-called ursol-colors, opened up a new field for the fur dyeing industry, especially as no particular skill as a dyer is required in using ursol colors; any tanner can, by giving the matter some attention, arrive at very satisfactory results.

As inquiries are often received from tanners as to the dyeing of fur skins, we take pleasure in placing before our readers herewith some of the latest developments in this field of industry, taken from the detailed results of a series of experiments with ursol colors made by two well-known German experts, the accuracy of whose observations have been personally verified by us. The account in question appeared in issues Nos. 13 and 17 of the *Faerber Zeitung*.

Ursol colors are manufactured by the Aktien-Gesellschaft für Anilin-Fabrikation in Berlin under the trade marks: Ursol D, Ursol P, Ursol C and Ursol DB. Of these D produces a dark brown and black, P a reddish-brown, C a yellowish-brown, and DB is specially adapted for bringing out a bluish or intense black. A large variety of shades can also be obtained by judicious blending of the various grades.

Before a skin can be colored it must first be tanned and prepared, and all grease removed from the hair so as to make it susceptible to the dye. The latter process is technically designated as "killing the skin," and if properly performed, does not rob the fur of its elasticity or injure the skin. Cold liquors must only be used in degreasing.

Among the methods employed for "killing the skin," the lime process is the one giving the most satisfactory results. It consists of treating with a degreasing liquid prepared in the following manner: Dissolve in two litres hot water 60 grammes powdered sal-ammoniac and 15 grammes aluminium sulphate, and add to this, stirring briskly, a milk of lime made by dissolving 200 grammes unslaked lime in four litres of water.

The resulting solution, which should be kept in well-covered stone jars, and should be stirred well before using, is applied with a brush on the fur side one or more times, according to how thorough a cleaning is necessary, and the skin is then placed to dry in the shade, in a not too warm place; if dried too rapidly, the hair loses its elasticity and the skin becomes hard.

When dry, the lime dust is removed by beating and brushing, and the skin is then ready for the (ursol) dye bath, although, if first treated with a mordant of bichromate of potassium and cream of tartar, a saving of dye will be effected, as well as the process of oxidation facilitated. Sulphate of iron or sulphate of copper may also be used as mordants when the skins are to be dyed black.

By replenishing with fresh potassium bichromate and cream of tartar in quantities equal to one-third of the original proportions, the bichromate bath may be used again; but after the same bath has served twice, or at the most three times, it is advisable to replace it by an entirely fresh solution.

After mordanting, the skins are rinsed and placed in the dye liquor, and, to insure a uniform color, care should previously have been taken to work them evenly and thoroughly in the bichromate solution, stress being laid on the point that they must always be handled fur-side down.

The method of dyeing will be best understood by a detailed description of a few representative examples.

For instance, rabbitskins may be dyed a brilliant golden brown in the following manner: The skins are cleansed thoroughly in a bath made up of about 10 grammes soap and 10 grammes ammonia to 10 litres of water, in which they are allowed to remain from 1 to 2 hours, during which time they are handled repeatedly; then taken out and rinsed thoroughly. They are next soaked for about 12 hours in a mordanting liquid of 20 grammes potassium bichromate and 10 grammes cream of tartar to every 10 litres of water; then removed and rinsed, and placed in the dye liquor, which consists of 6 grammes Ursol P to every 10 litres of water. After 10 hours' immersion, the fur will have taken on the desired color.

Goatskins (*Angora*) are dyed a medium yellowish-brown as follows—*Mordant:* 20 grammes potassium bichromate and 10 grammes cream of tartar per 10 litres water (time of immersion 12 hours). Rinse well and dye out with 10 grammes of Ursol P and 1 pint peroxide of hydrogen to 10 litres of water. Six hours is required for this process.

Ursol D, used alone, produces grey; with a bichromate mordant, violet shades, and if used in more concentrated form, black.

A beautiful dark brown for Thibet or wild goat is obtained as follows: *Mordant:* 40 grammes potassium bichromate and 20 grammes cream of tartar to 10 litres of water (12 hours); rinse well and dye for 24 hours in a bath made up of following proportions: 5 grammes Ursol D, 5 grammes pyrogallic acid, 300 grammes peroxide of hydrogen; 20 grammes ammonia, 10 litres water. If more rapid action is desired, a stronger dye liquor is used, viz., 20 grammes Ursol D, 10 grammes pyrogallic acid, 750 grammes peroxide of hydrogen, 20 grammes ammonia, 10 litres water. With the latter formula, the time required for dyeing is reduced to 1½ hours.

A grey-brown for wild goat is produced by mordanting with bichromate—cream of tartar and dyeing out with: Ursol D, 1

gramme; Ursol P, 1 gramme; pyrogallic acid, 1 gramme; peroxide of hydrogen, 100 grammes; ammonia, 10 grammes; water, 10 litres. Leave in dye liquor 12 hours.

Light brown for long-haired musk-ox: A solution, per litre of water, of Ursol P, 10 grammes; Ursol D, 8 grammes; pyrogallic acid, 10 grammes; peroxide of hydrogen, 100 grammes, and ammonia, 8 grammes, is made by first adding the two Ursols in a heated state; then the peroxide of hydrogen and pyrogallic acid, and lastly, when all the other ingredients have been incorporated, the ammonia. No mordanting is necessary, and the dye is applied with a brush and allowed to dry.

Imitation of seal-skin in clipped musk-ox: For *mordant*, use, as heretofore, potassium bichromate and cream of tartar, and color with a solution of 8 grammes Ursol P, 6 grammes Ursol D, 5 grammes pyrogallic acid, 125 grammes peroxide of hydrogen, and 5 grammes ammonia to 1 litre water. When dry, clean thoroughly, and apply with a brush to the tips of the hair a dye of 10 grammes Ursol D and 250 grammes peroxide of hydrogen to 1 litre of water. In about an hour the tips of the fur will show black and a strikingly deceptive imitation of seal-skin is the result.

Imitation nutria in clipped rabbit: Apply with a brush, a solution of 12 grammes Ursol P, 8 grammes Ursol D, 6 grammes pyrogallic acid and 100 grammes peroxide of hydrogen, to 1 litre of water.

Intense black for Angora goat or other similar skins: *Mordant* with 20 to 30 grammes potassium bichromate, and 10 to 15 grammes cream of tartar to 10 litres water (12 hours). The use of a more powerful mordant is not advisable, as it imparts a brownish tinge to the black. Rinse well and dye out with: 30 grammes Ursol D, 1 litre peroxide of hydrogen, in 10 litres of water. Twelve hours will bring out the desired color. A like proportion of sulphate of iron or sulphate of copper may be substituted for the potassium bichromate in the mordanting liquor, and the former will also be found very effective.

Ursol DB is especially useful in producing a blue-black tinge,

but in this case the potassium bichromate mordant must be replaced by one of sulpate of iron and cream of tartar, or sulphate of copper and cream of tartar, or a mixture of the two sulphates and cream of tartar, which all give excellent results.

Directions for producing a blue-black tinge are—*Mordants:* I. 20 grammes sulphate of iron and 10 grammes cream of tartar to 10 litres water (12 hours); II. 20 grammes sulphate of copper and 10 grammes cream of tartar to 10 litres of water (12 hours); III. 15 grammes sulphate of iron, 5 grammes sulphate of copper and 10 grammes cream of tartar to 10 litres water (12 hours). Dye out with: 20 grammes Ursol DB and 500 grammes peroxide of hydrogen to 10 litres water (10 to 12 hours).

When mordant I. is used the resulting black has a deep-blue tinge, and the skin itself remains a light blue. Mordant II. gives an intense black, while the skin also becomes black. By using mordant III. the skin remains lighter than is the case in either of the foregoing recipes, without, however, interfering with the desired tinge of the fur.

When the dye-bath is to be used over again, its strength may be replenished by the addition of a proportion of about 60 per cent. of the quantities used in the original liquor.

A peculiar advantage in dyeing with Ursol colors is their great coloring energy, which is especially noticeable when the dye is applied with a brush to the tips of the hair, or used to give a streaked appearance. For example, a single application of a solution of about 15 grammes of Ursol D and 100 grammes peroxide of hydrogen to one litre water, will be found sufficient to tip a fur with black or to tint lightly.

The appliances required for practical dyeing by the processes above described are: A boiler for heating water, several small vats, or sawed-in-half petroleum barrels to contain the mordanting and dye liquors, some racks on which to hang up the wet skins, an airy drying-room capable of being heated in cold weather, and finally an arrangement for rinsing, so that fresh water for that purpose may always be at hand. After each

operation the tubs or vats containing the liquors are covered over with wooden lids.

IMPROVEMENTS RELATING TO THE MANUFACTURE OF ARTIFICIAL FUR, BEAVER AND NUTRIA—J. BIERMAN, BERLIN, GERMANY.

Lamb skins are placed in a soap and water bath and then pressed out and brushed with a color solution prepared by dissolving 1 part by weight of Ursol D (paraphenylene-diamine), 2 parts by weight of Ursol P (paramidophenol), 1 part by weight of pyrogallol, 50 parts by weight of hydrogen dioxide, and 4 parts of ammonia in hot water, and diluting to the desired tint with cold water. After drying, the hair of the skins is combed with a wire comb, and a silky gloss is produced by ironing with acid. Beaver and nutria imitations are thus prepared.

WEIGHTS AND MEASURES USED IN THIS CHAPTER.

Kilogram (kilo),	metric	= 2.2046 pounds.
Liter,	"	= 1.056 quarts.
Gram,	"	= 15.432 grains.

CHAPTER XXXVI.

TAWING LAMB AND KID SKINS FOR GLOVE LEATHER, DYEING, ETC.

KID gloves are made principally from lamb and kid skins imported from Brazil, France and Germany. They come to this country packed in bales containing from 250 to 400 skins. In preparing the material for gloves, the skins have to pass through a number of processes such as washing, unhairing, paddling, tanning, staking, coloring, and polishing. The skins, which are about four feet in length and about three feet in width, are first placed in wooden tubs and thoroughly soaked in cold water. From 600 to 800 skins are placed in each tub and left to soften for from one to two days, according to the season. From the soaking tubs they are placed in a circular revolving drum and washed. This drum is about eight feet in diameter and about four feet in width and revolves at the rate of about sixty revolutions per minute. A number of wooden pins connected on the interior of the apparatus shift the skins about as it revolves, so that the stream of water which passes in at the center of the drum thoroughly saturates and frees them from dirt.

After washing for a quarter of an hour, they are taken out and placed in lime pits. These pits are about eight feet in depth, eight feet in length, and about five feet in width. From 800 to 1000 skins are placed in each of these pits and are covered with lime and water for about two weeks. The lime acts on the pores of the skin, opening them so that the hair can be easily removed. The skins are taken from the pits by means of long-handled tongs. To take off the excess of lime, the skins are paddled. This is performed by placing the skins

in cold water and running them back and forth over a paddle-wheel. This wheel is about three feet in diameter, about six feet in length, and travels at the rate of about 40 revolutions per minute. After paddling, the hair is removed by spreading the skins out over a beam, an operator then scraping off the hair by means of an unhairing knife.

A good workman can unhair about 20 skins per hour. The next operation is fleshing. A skin is placed as before over a beam, the operator cutting off the particles of flesh adhering to the skin, giving it an even thickness, and also trimming off the ragged ends. The scraps are sold to glue makers, and the hair to plaster and carpet manufacturers. About 20 skins can be fleshed per hour. After fleshing the skins are washed again in the revolving drum for half an hour, after which they are fleshed again to take off the grease. The material is then paddled again in warm water, after which the skins are spread out again on beams and slated, the process taking off the surplus dirt and giving them a finish. They are then paddled and then drenched in a tub of bran and water. About 800 skins are placed in the drench tub at a time, and paddled for 12 hours, the operation removing the lime and opening the pores of the skins. The skins are then put into a revolving drum containing a tanning liquor composed of alum, salt, flour, and the yolks of eggs. After revolving in this drum for twelve hours at the rate of 80 revolutions per minute, the skins are taken out and hung up on hooks in a drying room in a temperature of 110° F. for twenty-four hours.

When the skins are dry, they are dampened with water and put into a mill and softened. This mill consists of two perpendicular swinging planks suspended from the ceiling, connected to the bottom ends of which are large wooden blocks, which move back and forth when the apparatus is in motion. The dried skins to the number of 50 or more are placed on the floor of the mill in front of the blocks, which, as they move forward, squeeze and press them together until they become soft, after which they are staked. This is performed by draw-

ing the skins back and forth over the edge of a broad steel knife, about 18 inches in length and about 8 inches in width. After this operation, which also softens the material, they are put again into the drying room, after which they are staked again, the operation taking off the dried flour, which sticks to the material from the tanning liquid.

The white skins are then packed away for a few months to ripen for working purposes. The skins are then selected out for coloring, being first washed in a drum of cold water for 20 minutes, after which they are placed in a revolving bath of egg yolk for twenty-four hours, which softens and makes the stock pliable. The skins are then colored. A skin is first slicked out smooth on a lead covered table and given a wash of potassium bichromate and soda; the solution preparing the skin so that it will take the coloring ingredients. The gloves are colored in black, drab and tan, iron sulphate being used to produce black, zinc sulphate for drab, and sulphate of alum for tan color.

The coloring ingredients are poured on the skins with a cup and rubbed with a brush. The skins are then dried and staked again, and then polished over a flannel covered wheel. The raw skins cost now (August, 1897) from $7 to $9 per dozen.*

BLACK ON GLOVE SKINS.

771 grains logwood extract and 154 grains fustic extract are dissolved in one quart of water; the leather is, at 99 degrees F., brushed five times with this liquor. Next 154 grains chromate of potash and 77 grains sulphate of copper are dissolved in one quart of water, and the leather is brushed twice with this solution; after it has been absorbed, the leather is brushed another time with the logwood solution. When half dry, it is to be rubbed with aqua ammonia (154 grains per quart of water), using a woolen cloth; it is brushed afterwards with water, and then treated with yolk of egg and glycerine.

* *The Scientific American.*

Another black for glove leather is prepared as follows: In two gallons of water heated to 115° or 120° F., dissolve two ounces logwood extract and two and a-half drachms of fustic. In another vessel dissolve two and a-half drachms bichromate of potash and one drachm of sulphate of copper in a pint and a-half of water. The first liquor is used to rub into the skin several times. The second liquor is the blacking; after it has been applied, another coating of the first liquor is given. Finally the leather is washed off with water containing ammonia, and finished as usual. For other colors and shades on glove leather see Chapter on Dyeing.

CHAPTER XXXVII.

TO PUT A GLOSS ON BLACK LEATHER.

THERE are seven different solutions which may be used for putting a handsome and brilliant gloss on black leather, and the following are the methods for manufacturing them:

1. Take ten parts of albumen, and dissolve them in ninety parts of water. Blood albumen is the best. The water may be either cold or tepid, but its temperature must never be more than 70° F., or the albumen will not dissolve. White of egg may also be dissolved in its weight of water. The solution is put on by means of a soft sponge. Directly afterward the skins must be hung up in a place protected from the dust and sun.

2. A solution of gum-lac. Mix up together in a litre (1¾ pints) of water, 100 grammes (3½ ounces) of borax, and 200 grammes (7 ounces) of gum-lac, and boil until the whole is entirely dissolved. Then add 200 grammes (7 ounces) of negrosine, and leave it to cool. The solution is put on with a sponge.

3. Caseine dissolved in ammonia. Take a certain quantity of white cheese finely ground and put it with some ammonia previously dissolved in a quantity of water of equal weight. By means of evaporation a substance is obtained which constitutes a varnish of uncommon richness.

4. Algine dissolved in water in the proportion of 12 to 100.

5. China moss dissolved in water. Boil it for two hours.

6. A varnish called panclarite, which is made in the following manner: Dissolve 100 grammes (3½ ounces) of soap of rosin and 900 grammes (31½ ounces) of ordinary glove skin, finished off with from 30 to 60 grammes (1.05 to 2.1 ounces) of glycerine. When the solution has the appearance of a jelly, spread it over the skin with a sponge.

7. A liquid composed of the following ingredients: 200 parts water, 4 parts potash, 20 parts carnauba wax, 10 parts sugar, 10 parts rosin, 5 parts glycerine, and 2 parts aniline. Boil the mixture for half an hour, and add 200 parts glove gelatine. Let it cool and put on with a sponge.

The above are the seven newest processes for putting a gloss on black leather. The processes can be modified so as to include glove leather; but as given are for any kind of black leather.

CHAPTER XXXVIII.

SHEEP LEATHERS.

FEW people realize the importance of the sheepskin industry or the number of uses to which sheepskins are put. Last year (1896) at Chicago alone there were received 3,406,739 head of sheep, of which number 2,932,093 head were slaughtered at the packing houses. The skins of these 2,932,093 sheep were disposed of for various purposes, in fact more than the average reader has any idea of. We have been able to obtain a portion of the uses for which these skins are suitable, and give them herewith as follows: The greatest demand probably comes from shoe manufacturers, who use a large number of skins annually in making up cheap shoes. The linings and uppers of thousands of pairs of shoes are made from sheepskins, although there is little to say of the wearing quality of shoes whose uppers are wholly composed of this class of stock. The second largest demand comes from the manufacturers of gloves and mittens. Many a pair of gloves which have been made from sheepskins are sold as genuine buckskin gloves, but the demand for cheap gloves and mittens makes it possible for manufacturers to palm off the sheepskin glove for something better than it really is.

Next in order comes the demand from the bookbinders, who consume large quantities of sheepskins in the binding of books. The manufacturers of satchels, hand-bags and pocket-books, use very large amounts of skins, in fact, we dare say that the bulk of these goods are made from sheep pelts. Even the better class of these goods, which are not made wholly from pelts, are lined with them. To-day there are less of these goods made from sheepskins than formerly, owing to the lib-

eral use of canvas, which takes the place of these skins. Continuing the list we find the following articles are made up wholly of the skins from the animal with the "golden hoof:" Saddle-pads, harness, boxing gloves, baseball covers, bindings of gun cases, gussets in overalls, binding of pockets for street-car conductors, linings for hats (which takes thousands of skins), bellows, plasters, children's toys of almost endless variety, imitation chamois skins, saddletrees in place of rawhide, drum heads, slippers, leather clothing, catchers' gloves, heel protectors, chair seats and purses. Heavy skins are used for blacksmiths' aprons and command a good price for large sizes. Skins that have the wool left on are also put to numerous uses, among which we mention coats, mats, mittens, gloves, caps, sleigh-robes, boot-linings, and long wool dusters.

The cold sweat process is used in a limited extent in this country for unhairing sheepskins in order to keep the wool in a clean condition, as it would be destroyed by contact with lime or other alkalies.

Sodium sulphide is an agent which is more largely used for unhairing sheepskins. Sodium sulphide, when mixed with the lime during the slaking process, enters into chemical combination with the lime, forming varous mixed sulphides which have a much more energetic action on the skin, dissolving out all the keratines, but not swelling the skin to the same extent as lime alone; the addition of sodium lessens the time required to lime a skin, attacks the hair and weakens it or dissolves it, according to the quantity used. It, however, produces a coarser grain on the skin, and at the same time does not take so much out as lime does alone.

Arsenic, if mixed in the same way, also forms sulphides and hydrosulphides of lime and arsenic, which also have a more energetic action on the skin than lime alone, and produce similar results to lime and sulphide of sodium, but give a finer grained skin, with more gloss.

In the tanning of sheepskins it is necessary to remove the grease. To remove grease from raw sheepskins, the skins after

liming are usually pressed between strong presses, hydraulic or otherwise, the skins being sprinkled with sawdust to prevent them from slipping.

For raw skins or limed goods the pressure method appears the simplest, and, being very effective, the best. Sheepskins for mats with the wool are plastered with fuller's earth or whitening on the flesh and put in a hot room, a process very effective for this particular purpose.

The skins are then bated. The object of bating and puring skins is, first to remove all lime salts contained therein, and, at the same time, to rid the skins of the hair sacs, coriin, albumen etc., and to dissolve out a certain amount of the skin substance, rendering the leather softer and more pliable, at the same time to partially bring down the substance of the skin, which has been unduly swollen by the previous process of liming. Many other compounds have been patented as substitutes for hen or pigeon excrement.

Among such are sulphuric acid, hydrochloric acid, the Tiffany bate, which is composed of glucose and stale cheese, ammonium chloride, cresotinic acid, borophenol, etc. In some factories some of these have proved very succesful, and are rapidly gaining in favor. Some experiments have been made with using pure cultures of the various bacteria which are found in ordinary bates. These can now be bought on a commercial scale.

The skins are then ready for the tanning process, but their treatment here depends upon the kind of leather into which they are to be made.

Some manufacturers wash the skin after bating in warm water, softened with borax in the proportion of one pound of borax to the 100 gallons, and then flesh them; but as previously stated, this depends upon the kind of leather into which the skins are to be made.

The Vaughn Machine Co., Peabody, Mass., build a shaving and skiving machine for sheepskins. It is constructed on the same principle as their fleshing machine; but it is especially fitted and adapted for this purpose. The machine will shave

the stock either partly or fully tanned, clearly and evenly, and without tearing or scratches. The capacity is from 100 to 150 dozens per day.

IMITATION CHAMOIS LEATHER,

Which is remarkable for its soft texture and porous nature, is prepared by the action of oil on the raw skin. Chamois leather was formerly made from the skins of sheep, calf and chamois goat—hence its name. Now, however, the flesh split of ordinary sheepskins is used. The skins receive a thorough liming, and are then split. The flesh split generally receives a still further liming in order to remove the coriin and other soluble matters from between the fibres. The fleshes are now frequently subjected to a bating process, and a short bran drench, which, at the same time, secures the complete absence of lime.

After the usual beam work, the skins are pressed or hung out to remove surplus water, and while still moist are sprinkled with oil on a table and folded in cushions, three or four skins together, and are stocked for two or three hours, shaken out, and hung up for about an hour to cool and partially dry. They are again folded in bundles and stocked for a short time, taken out, re-oiled, and again returned to the stocks. This process is repeated until the skins lose their original smell of lime, and acquire a peculiar mustard-like color, and the water which was at first present has been entirely replaced by oil.

When the oiling is complete, the skins are piled in heaps on the floor or in boxes. The oxidation of the oil, which has already commenced during the process above described, is completed by a process of fermentation in which the skins heat very considerably. They must be carefully watched, and if the heat rises so high as to endanger the quality of the leather, the pile is turned over, the skins being turned out to cool, and then put back into pile. When this fermentation process ceases and the skins are no longer susceptible of heating, they are then treated to remove the surplus oil. This on the Continent is done by throwing the skins into hot water, and wringing or squeezing out the oil (degras). In England,

however, the oil is generally removed by washing the skins with soda or potash lye. The partly saponified oil which is pressed out is recovered by neutralization with sulphuric acid, and forms the sod oil of commerce.

The finishing process consists of staking during drying to retain the softness, and smoothing the flesh on the fluffing wheel. They may be bleached by sprinkling with water and exposure to the sun, or by treatment with a weak solution of permanganate of potash, and subsequently with very dilute sulphuric acid, or may be treated with sulphurous acid in gaseous form. (See Chapter XL.) In the United States and on the Continent of Europe, the skins, instead of being laid in piles to oxidize and ferment, are usually hung up in warm rooms. This is much less dangerous, and produces a better color.

WHITE LEATHER.

Glove kid or calf kid or white sheep leather are all white leathers. After the soaking and liming of the skins, which is usually done by pasting them on the flesh side with a mixture of sodium sulphide or arsenic, they are, after unhairing, thoroughly washed in water, well scudded on the beam to get dirt and scud out, trimmed and then pured in a weak pure, about one to one and a half pails of paste for 200 skins, sufficient to make the water opaque, but not soapy.

After puring, the skins are again washed and worked on both flesh and grain, and are then drenched for from six to ten hours. The skins are now ready for tawing. The tawing paste consists generally of a mixture of flour, egg yolk or egg preparation, alum and salt. This may be done in a drum, or may be trodden in by foot, the latter process being the Continental one. If the drum is used, care must be taken that the skins are not allowed to get too hot in the drum.

After tawing, they are hung up in a cool place for the paste to set, dried in a cool place, and then hung for a few weeks to soften and absorb moisture. They are then staked, fluffed on the flesh, and are now ready for dyeing or finishing.

CAPE SHEEP.

This class of goods, being of coarse texture, and not used for the finest purposes, the ordinary pit process is usually employed. The skins are unwooled by the sweating or painting process, and then further limed to thoroughly swell the goods. After liming, they are fleshed and scudded, may be lightly pured and bran-drenched after working on the beam to remove bran, scud, etc.

The goods are now tawed in a paddle or ordinary pits, with a liquor made from hemlock or other common bark. The tanning in paddle lasts from four to ten days, with liquors of constantly increasing strength; if in pits, the process takes from two to four weeks. The skins are now lightly oiled on the grain with fish or linseed oil, damped, staked and re-dried.

LINING, BINDERS AND SKIVERS.

The manufacture of sheep-skins into linings, bindings and skivers is an important one. The sheep-skins used are both domestic and foreign; those derived from Great Britain are mostly "sheep-skin fleshers," and are treated with vitriol before shipment to preserve them. A flesher is the backside of a sheepskin. They are first milled in salt and water, to neutralize the acid, and are then run out on the beam.

The materials used for tanning this variety of leather are usually hemlock bark, oak wood extract, sumach, gambia, and alum.

These skins are finished in all colors; hemlock is used for colors darker than its own, sumac is employed for white and fancy colors, and alum mostly for those that are to be dyed black.

The sheep-skin fleshers are split from the sheep-skins while in a state of pelt, and special machines are required for this operation. We show in Fig. 126 an exterior view of a sheep-skin tannery.

The processes which we shall first describe are for those skins which arrive at the tannery from foreign countries, split, free from wool and which are pickled.

Sometimes these skins are placed in clean water and washed; but they are not uncommonly removed from the casks in which they were shipped and immediately soaked in salt and water, worked out on the beam and placed in the tanning liquor, whether it be hemlock, sumac, or alum.

In hemlock and sumac they remain about ten or twelve days, the strength of these liquors being gradually increased every thirty-six hours, and in alum the skins remain for a much shorter time. After being tanned, they are removed from the vats with a hook and piled, and left to drain, as shown in Fig. 127.

The skins are then carried to the drying lofts and each one hung upon two hooks, but so placed that the skins do not touch.

Fig. 128 shows an interior view of a drying loft in a sheep-skin tannery, with the skins hanging upon hooks to dry.

After being dried the skins are removed from the hooks in the drying loft, and transferred to the "putting out department," where they are wetted and tacked to boards used for putting out. After this operation they are again hung up in the loft to dry, and then carried to the "finishing-room" and finished on the machines employed for that purpose; but if they are to be dyed, they are carried to the dye-house and colored in various hues, aniline colors being generally employed.

After being dyed, the skins are again hung up in the lofts to dry, and are next carried to the finishing department, shown in Fig. 129, and rolled, glassed, or pebbled by machines used for the purpose, and which have been illustrated and explained in detail in Chapter XIX.

After being finished on the machines, the skins are measured, marked and bundled ready for market.

DRESSING SHEEP-SKIN FLESHERS FOR GLOVE BINDINGS, ETC.

The following process for dressing "sheep-skin fleshers," to be used in the manufacture of gloves, for hidings, etc., was patented in 1875, by Richard Hart, of Gloversville, N. Y., the patent having, however, now expired.

The quantity of the mixtures to be specified is intended for

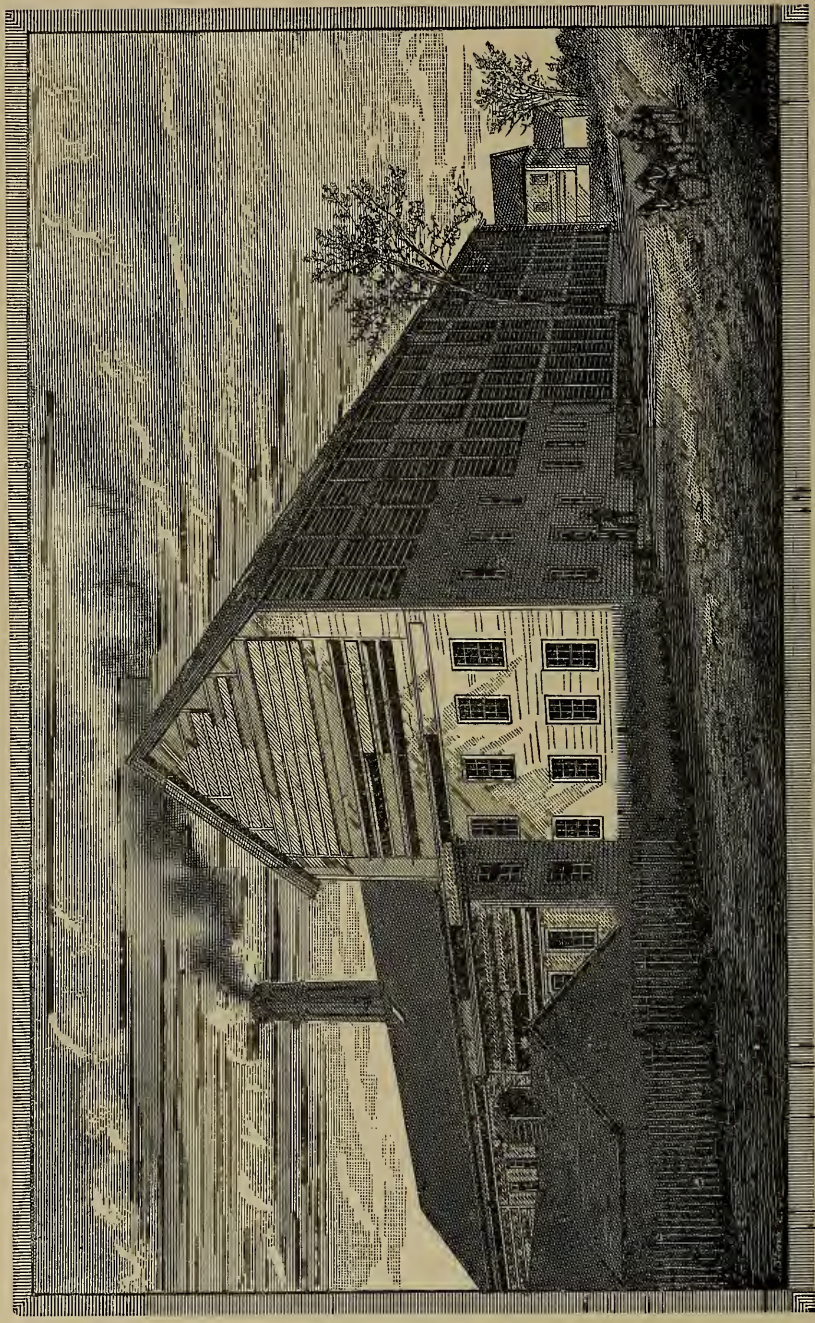


FIG. 126. EXTERIOR VIEW OF A SHEEPSKIN TANNERY.

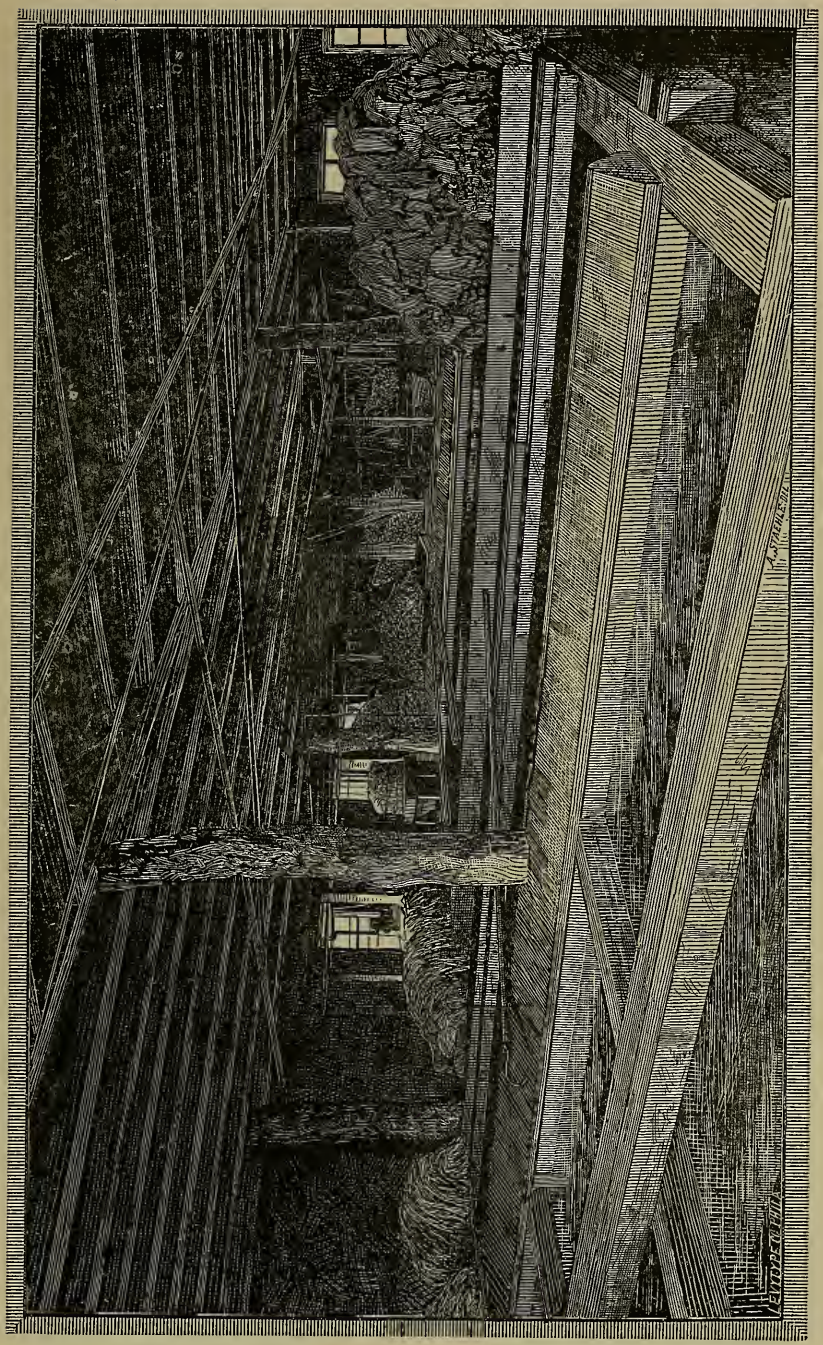


FIG. 127.

TANNING-VATS IN A SHEEPSKIN TANNERY.

Fig. 128.

DRYING-LOFT IN A SHEEPSKIN TANNERY.

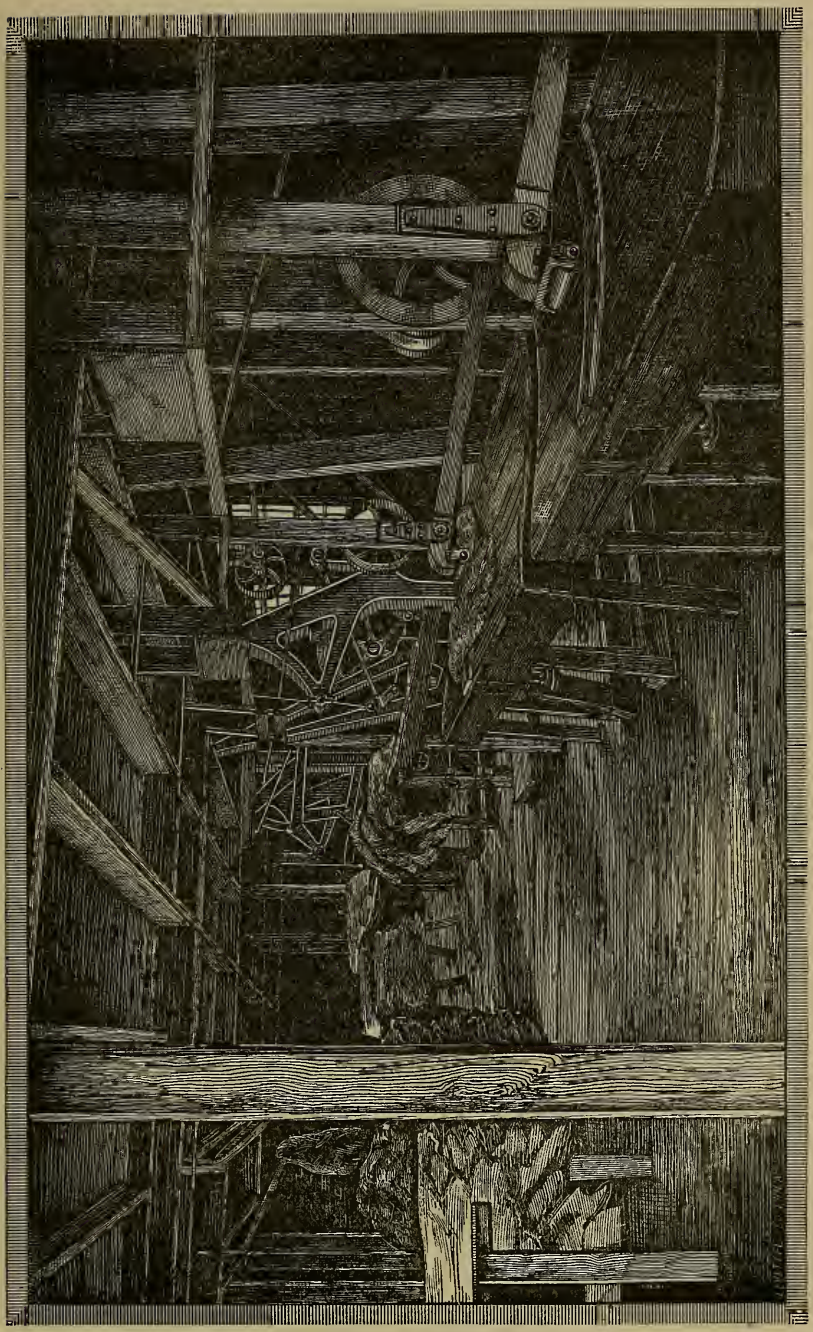


FIG. 129.

FINISHING ROOM IN A SHEEP-SKIN TANNERY.

about two dozen sheep-skin fleshers of the ordinary size. In carrying out the process, first immerse, pound, and stir the skins for about one-half hour in a fluid mixture, prepared as follows: Dissolve one pound of alum in one and a half gallons of water, which is readily done by boiling. Then mix in a separate vessel, one-half pound each of flour and oatmeal, or one pound of either alone, with one gill of oil and one and a half gallons of water, and mix this composition with the alum-water. At the expiration of the designated time take the skins out of this mixture and stretch them, and remove the ground work and knife-marks from the grain side. Then immerse them for about the same length of time, and with the same manipulations as before, in a fluid mixture, prepared as follows: One gill of urine, one-half bar of bar-soap, one-half ounce of soda, one-half pound of salt, and about two ounces of whiting or ochre, all boiled in one and a half gallons of water until they are thoroughly dissolved, to which are added one-half pound of flour and one-half pound of oatmeal, or one pound of either alone, mixed in one and a half gallons of cold water. The skins are then dried, stretched, and staked out, and can now be faced or finished upon either side in the usual manner.

Instead of urine in the mixture last described, a small quantity of ammonia may be used, as it produces the same effect; or the proportion of soda may be suitably increased, or lactic acid may be used, and neither urine nor ammonia be employed, and still the desired result obtained.

Skins dressed by the usual method can be finished or faced on the flesh side only, and have a rough and hard surface on the grain side, besides being rough and stiff in texture.

Skins dressed by this process, by treatment to both mixtures, may be finished on either or both sides, and, it is claimed, are made soft, pliable, and with elasticity or "spread" and stronger in texture, without becoming rough.

Skins which are treated to the first mixture only may be at once dried, staked, and stretched, and finished on either or both sides in the usual manner, without subjecting them to the

second mixture, and, it is claimed, will then be better in quality, and have a susceptibility of better finish, than skins dressed in the ordinary way; but it is preferable to employ the entire process in dressing skins, as they are thus given a superior quality and a capacity for higher finish than when the first part of the process only is used, and, when finished, bear a close resemblance in texture and quality, to deer-skin or castor.

MANASSE'S METHOD FOR TAWING SHEEP-SKINS.

In 1875 Emanuel Manasse, of Napa, California, patented the following process for tawing sheep-skins:

The skins are taken from the sweat-house, and, after being properly treated in the beam-house, are immersed in a solution, composed for two hundred skins, of the following ingredients:

No. 1. Twenty pounds of salt, thirty pounds of white-rock potash, three hundred gallons of water.

The skins remain in this solution for about two hours, and are then wrung out dry, and immersed in a solution composed as follows:

No. 2. Twelve pounds of hard soap and two gallons of neat's foot oil in one hundred and fifty gallons of water.

After being kept in this solution long enough to wet them through, the skins are removed and hung up to dry, and are wet and dried in this manner two or three times.

After being thus treated and properly tawed, they are put in a dry state into clear water, and washed in a thorough manner to remove all foreign matter from them, and in this moist condition are dried to produce leather of various colors, or, if a white leather is required, they are allowed to dry without further treating.

The proportions of the ingredients given above may be changed, as the nature of the skins requires, without affecting the process.

It is claimed that the skins thus treated combine the qualities of softness, pliability, and toughness, which allow the leather to be sewed together, as in the manufacture of gloves and like articles, without tearing or allowing the stitches to pull out.

HIBBARD'S PROCESS FOR PREPARING AND TANNING SHEEPSKINS.

Hibbard's process for preparing and tanning sheepskins for linings, binders, etc., is as follows:

To remove the hair, mix the following composition with water sufficient to make a thick paste, apply it to the flesh side of the hides, fold the skins and keep them at a temperature of summer heat. In a few hours they are ready to pull.

Quicklime (freshly slacked)	½ bushel.
Wood ashes	½ "
Salt	3 pints.

For the liming process use the same composition, mixed with sufficient water in a vat to immerse the number of skins proposed to be limed. One bushel is equivalent to one bushel of lime alone. The liming is done at the temperature of 60° F.

For tanning six dozen full sized sheep, deer, goat, or similar skins, prepare the following composition:

Salt	18 lbs.
Sulphuric acid	2 "
Sumac or quercitron bark	36 "
Hydrochloric acid	2 ounces.
Dried clover	18 lbs.
Water	125 galls.

Exhaust the sumac or bark by water, add the salt, enough to insure perfect solution, then add the acids and incorporate by stirring.

HESTHAL'S PROCESS FOR DRESSING SHEEP-SKINS, ETC.

The following process was patented in 1883, by August Hesthal, of San Francisco, Cal., and is useful in the preparation of leather for button-pieces, linings, stays, and other small articles.

The process is especially applicable to sheep, lamb, kid, and deer-skins. The skins after having passed through the sweating process and been properly treated in the beam-house, are placed in a solution which we will call No. 1, composed of two

pounds of caustic soda, one pound of borax, and sufficient water to cover the skins—say one hundred gallons.

The skins and compound are contained in a suitable drum, in which they are run for a half hour and then removed and hung up to dry.

They are then immersed in a solution which we will call solution No. 2, composed of five pounds of hard soap, one gallon of straits oil, one-half pound caustic soda, and seventy-five gallons of water.

In this solution they remain long enough to become soft and wet through, after which they are put into a drum with a part of the composition No. 2, and run for about a half hour, being then removed and dried as before.

They are next softened in the composition No. 2, and then allowed to drip.

They are then again placed in the drum with a solution which we will call No. 3, and run for about a half hour; then put back into the composition No. 2 and soaked for one hour, and then taken out and hung up to dry, after which they are soaked and dried in this manner two or three times in composition No. 2 until they are properly prepared, as some skins may need to have this part of the process repeated a greater number of times than others. After the skins are treated in this manner and have become leather, they are put in a very weak solution of composition No. 2, in order to thoroughly soften them, and in this wet condition they are dyed in different colors; or, if white leather is required, they are allowed to dry without further treating. In this manner is produced a leather which is strong and pliable, and when sewed together it does not crack, nor do the stitches pull out; and as the skins are prepared without the employment of lime and sulphuric acid, it leaves the fibres in their natural state and strength.

The proportions of the ingredients given in the above solutions, Nos. 1, 2 and 3, are estimated for about one hundred and twenty sheep-skins.

COLORING FOR FIVE DOZEN SHEEP SKINS.

BLUE-REDDISH.

Preparation of the Skins for the Dye Bath.—Fill a tub with 15 pailfuls of warm water; to this add 1¼ lbs. sal soda. After it is dissolved, take the five dozen skins and put them in, pounding them for five minutes; then take them out and place them in a tub containing 15 pailfuls of warm water, pounding them for four minutes. Take skins out, fill a tub with 15 bucketfuls of cold water, add to the same 1½ pints oil of vitriol; stir it well; put the five dozen skins in it and handle them for five minutes. This done, withdraw them and place in a tub of cold water, letting them remain ten minutes. After this, fold them together.

Dyeing.—Fill a dye-box with ten pailfuls of warm water; to this add 1 oz. blue-reddish aniline, which has been previously boiled one minute in half a pail of water and half a tumblerful of oil of vitriol.

To the dye-box add half a tumblerful of oil of vitriol. Put one dozen of the folded skins in, handle them very quickly for three or four minutes; then take them out and wash them in cold water. For every other dozen add to the box ¾ oz. blue-reddish aniline and half a tumblerful of oil of vitriol. Warm the liquor in the box; color the rest like the first.

BLUE-BLUISH.

The same preparation of the skins for the dye bath as blue-reddish. After skins are folded, fill a dye-box with four pailfuls of warm water. Add to the same 1 oz. reddish-brown aniline. This must first be added to a half bucketful of water and boiled three or four minutes. Put one dozen of the folded skins in the dye-box and handle them four times forward and back. Then take them out and wash them in cold water. For every other dozen warm the liquor up, and add 1 oz. reddish-brown aniline.

COCHINEAL.

The same preparation of the skins for the dye bath as blue-reddish. Fill a box with three to four pailfuls of milk-warm water; add to this 2 ozs. borax, dissolved in 2 quarts boiling water. Take 1 dozen folded skins and handle them twice forward and back; then take them out, and add for every other dozen skins 2 ozs. borax dissolved in half a pailful of boiling water. Let the skins remain in the borax over night. Fill a vessel with 12 pailfuls of boiled water; add to the same ¾ lb. turmeric and 2½ lbs. fine ground cochineal. Let this boil 20 minutes. Add to the same liquor 5 ozs. pearlash and 3 ozs. alum, and boil 3 minutes longer. Of the boiled liquor, put in a dye-box four pailfuls. Place thirty skins one by one in the liquor. After this add two pailfuls of cochineal liquor to this dye-box; put the skins in it and handle them twenty minutes forward and back; then take them out. Color the rest as the first.

LEMON YELLOW.

Same preparation of the skins for the dye bath as blue-reddish. After skins are folded, fill a dye box with four pailfuls of warm water. Add to the same 3 ozs. picric acid dissolved in one-third of a pailful of boiling water. To the same box add half a tumblerful of oil of vitriol. Stir it well, bring one dozen of the folded skins in and handle them very quickly four or five minutes. Take them out and wash in cold water. For every other dozen skins warm the liquor in the dye box and add to same 1½ ozs. picric acid. Color the rest as the first.

GRASS GREEN.

Preparation of the Skins for the Dye Bath.—Fill a tub with 15 pailfuls of warm water, add 1¼ lbs. sal soda. After it is dissolved, take the five dozen skins and pound them five minutes; take them out and fill a tub with 15 pailfuls of warm water. Put them in and pound them four minutes. Take out and put them in a tub of warm water. Let them remain 10 minutes. After this fold the skins.

Dyeing.—Fill a dye box with 4 pailfuls of warm water, add to the same 2 ozs. bichromate of potash dissolved in half a pailful of boiling water. To the box add half a pint chemical blue. Stir it well, and put one dozen of the folded skins in it, and handle very quickly four or five minutes. Take them out and wash them in cold water. For every other dozen skins warm the liquor up in the dye box; add to the same 1 oz. of bichromate of potash, dissolved in one-third of a pailful boiling water. To the box add one-third pint chemical blue. Stir it well and color all the skins like the first dozen.

CLARET OR MAROON.

Same preparation of the skins for the dye bath as grass green. Fill a vessel with 15 pailfuls of water, add to the same in a bag 25 lbs. logwood. Let this boil two hours; take the bag out. Put in a box 7 pailfuls of warm water, add to same 1½ lbs. alum dissolved in half a pailful of boiling water. Take 30 of the folded skins, place them in it, and handle them three times forward and back. Take them out, and fill a dye box with 7 pailfuls of the boiled logwood liquor. Handle the skins four times forward and back, take them out.

If a darker shade is wanted, add to the same liquor 3 ozs. bichromate of potash dissolved in half a pailful of boiling water. Handle the skins twice forward and back. After this wash in cold water.

PINK.

Same preparation of the skins for the dye bath as blue-reddish. After the skins are folded, fill a dye box with four pailfuls of milk-warm water, add to this ¼ lb. sal soda, dissolved in one-third pailful of boiling water. Handle one dozen of the folded skins in it twice forward and back; take them out, add to every dozen skins ¼ lb. sal soda dissolved in half pailful of boiling water. After two hours fill a vessel with 10 pailfuls of water (after boiling); add to same 1½ lbs. cochineal. Let this boil 20 minutes, then add to the same 1½ ounces saleratus, 1½ ounces salts of tartar, 1½ ounces cream tartar, 2 ounces

alum. Let this boil three minutes longer. Take this boiled liquor, put three pailfuls in a dye box, and handle 30 skins one by one through the liquor. After this add two pailfuls from the cochineal liquor, put the skins in, and handle them 15 minutes forward and back, then take them out. Color the rest as the first.

SOLFERINO.

Same preparation of the skins for the dye-bath as blue-reddish. Fill a dye box with four pailfuls of warm water, add to same 1 oz. fuchsine dissolved in half a pailful of boiling water. Take 1 dozen of the folded skins and handle them very quickly three or four minutes. After this, take them out, wash them in cold water. For every other dozen skins, warm up the liquor in the box, and add to same ½ oz. fuchsine dissolved in one-third of a pailful of boiling water. Put one dozen of the folded skins in and handle them three or four minutes. Color the rest as the first.

For the above processes of dyeing sheep skins, we are indebted to "Hides and Leather," of Chicago, and for some other matter in this chapter we are indebted to the answers made to technological questions by candidates at the examinations of the City and Guilds of London Institute, as reported by the Leather Trades Circular and Review of London.

DYEING BARK-TANNED SHEEPSKINS INTENSE DULL BLACK.

In Switzerland they produce an even mat-black on bark-tanned sheepskins by washing the skins thoroughly and putting them in a sumac bath. To 100 skins, according to size and weight, they take 20 to 30 pounds of sumac and wheel the skins in this bath two or three hours, then wash them out and on the table or in the machine press them out, slate them and stretch them on frames to dry. To black them they rub them over with a strong decoction of logwood with a small addition of aqua ammonia; this makes them quite dark; they are then colored with a good vinegar black. After the skins are dry after the first blacking, they are again rubbed over with logwood and iron black.

CHAPTER XXXIX.

ELECTRIC AND OTHER RAPID TANNAGE SYSTEMS.

THE Groth system of rapid tannage by means of electricity has, so far, been demonstrated in the United States, at Kansas City, Mo., where good results are claimed for it, turning out 100 pounds of hides in six weeks without the aid of chemicals, extracts, concentrated or heated liquors. Groth's is-no-drum system, the ordinary tan pit being all that is required with a light wooden frame on it and the electric plant. This system we understand has not been a success in Germany, where it has been tried on a large scale. L. A. Groth, Stuttgart, Germany, is the name and address of the inventor.

One inventor, E. Worms, Paris, France, claims to hasten the tanning process by gradually and moderately heating the hides and the liquor within a closed vessel excluding air, and at the same time "expelling the water from the cells of the hides by electrically decomposing it." The hides are submerged in water in a rotating drum, and a tannin extract of 20° B. is run in, in the proportion of 50 per cent. of the weight of the hides, together with a "vegetable solvent" amounting to "5 per cent. of such weight." The drum is closed and rotated. When the temperature has risen to 59° F., an electric current is passed through the liquor by means of a suitable circuit, the temperature being maintained by its means at 77° to 86° F. When the process is half completed the circuit is broken and fresh tannin is introduced. Light hides are said to be tanned in 24 to 48 hours, heavy hides in 60 to 105 hours.

Finot, Ward, Gaulard, Meriten, Crosse, Rhodes and others, have all invented processes for electric tannage, but we have heard no reports of their general employment.

M. C. Dizer & Co., of East Weymouth, Mass., who operate a tannery in conjunction with their shoe factory, are believers in quick tannage and are making experiments constantly. Douglas M. Easton, who has charge of the tannery, states that in the past six months they have tanned by his special 2½-hour process, over 200,000 kangaroo skins and 60,000 wax calfskins. They are developing with more or less success a quick tannage of sole leather, and claim to have made, with extract, prime leather in eight hours. They have also been experimenting with the chrome process on sole leather, and are to build an addition for its practical operation.

The F. Durio, the Velocitan, and many other processes of quick tannage have been before the trade for some time, but we have heard little of them as being generally successful.

Mr. S. Käs, in the *Oestereich-Ungarisches Lederblatt* writes on this subject: "With the various patents for rapid tannage which are published almost daily, it is very difficult to judge of the real merits, and they should not, as they are, be all considered as being one and the same thing. Most of the patents of rapid tannage issued lately refer to mineral tannage with chrome salts, aluminates, tin and other metallic salts, and are almost exclusively employed for the tanning of light small skins, such as calf, goat and sheep. Their value does not depend upon rapidity, for by present methods the tannage is rapid enough, but in an improvement in the quality of the leather produced. So that when rapid tannage is spoken of nowadays, an extra rapid tannage in one, two or three days is meant. Of such systems as this there are but few known or offered for sale. We refer to rapid tannages for heavy sole, harness and belting leather. These systems are few, and of these still fewer are of any practical value."

The past two years have witnessed a notable revolution in quick tanning processes. And the revolution has been on comparatively new lines. Instead of trying to force tannin into the hide, the latest method is to employ chemicals to thoroughly cleanse the hide of all impurities, thus making the

texture unusually open and receptive to the tannin. Nor is the system followed, of beginning with weak vats and leading up to strong liquors. The new scheme means the application of strong tan liquors, or extract, to the hides or skins as soon as they leave the beam house. Nor are the hides and skins laid away. After being fleshed, unhaired and drenched they are put in a drum with extract and tanned in a remarkably short time. But leathers tanned in this way lack firmness and weight.

Men who are paying attention to the new quick tanning processes, confidently assert that good sole or harness leather can be made in ten hours. They consider thirty hours unusually long. The practical tanners who are investigating the promises of the new tanning, are hopeful that something has been discovered whereby the cost of the leather production, particularly the commoner sort, will be considerably reduced. By the new method, extracts can be used exclusively, and tanneries established in any part of the country, irrespective of the nearness of the bark supply.

Many good processes for rapid tannage have come up, but proved too expensive, or had other drawbacks, and were, therefore, neglected. One genius many years ago believed he could tan leather rapidly by forcing liquors through the hides by hydraulic pressure. This idea has disappeared in company with numerous other fads and notions designed to help tanners, and gotten up usually by men who had little or no acquaintance with practical tanning.

Taught by the failure of others, there are companies now selling to tanners quick tanning processes that have merit enough not only to deserve serious consideration, but to warrant fair trial. The owners of such processes do not make any wild claims. Their methods of doing business entitle them to attention from enterprising men.

It will occur to all that, as quick-tanning processes come to be better understood and more generally adopted, the somewhat speculative character of leather manufacturing will be less pronounced. Manufacturers of shoes and other leather pro-

ducts have a great advantage over tanners in the fact that a comparatively short interval occurs between the purchase of their leather and the sale of the goods made therefrom. Tanners, more especially those making sole, harness, belting leathers, etc., have to wait from three to six months after soaking a batch of hides before the latter are ready for market as finished leather.

The quick-tanning processes on the market to-day are attracting attention on account of their value and economy. Some excellent sole leather is being put on the market regularly each week in the United States, the tanning of which has been accelerated by novel methods. Harness leather of good, marketable quality has been made in eighteen days. The time required for producing upper leather has been reduced, although this is due largely to improved methods discovered by the tanners themselves.

It must be admitted that tanners are somewhat prejudiced against testing the merits of new processes. It is doubtful if there is a tannery in existence to-day where considerabe money has not been sunk in experiments. This of itself should not be an insuperable barrier to the introduction of further trials and experiments. Regulation of production would be much more easily governed if leather could be produced in comparatively short time. Less capital would be necessary than at present, which is a highly important item.

Tanners as a body are somewhat suspicious of new processes that do not originate in their own plants. Pressure of competition among themselves, however, is already inducing them to look with more favor on new schemes which promise well for the making of good leather at reduced cost of production. The trouble is that details of new tanning processes, as a rule, are so rigidly guarded that tanners feel somewhat nervous about agreeing to pay for something about which they are kept in the dark. The inventors of rapid processes, on their part, would be at the mercy of the tanners if they consented beforehand, without promise of pay, to disclose their secrets. On the

whole it may be said that while both parties to transactions are bound to take fair precautions to protect themselves, there is such a thing as too much conservatism, and those who are willing to take some chances are more likely to win in the end than their less courageous brethren.

The bark methods of tanning are passing away with great rapidity, extracts and chrome are taking their place, and in the larger establishments the chemist has become an invaluable part of the personnel of the tannery, and he is kept busy making investigations and suggestions.

The old-time tanner has now gone the way of his fathers. It is now certain that more advanced methods will be used by tanners in general in the near future, or a new and different generation of leather producers will step forward to fill the places of those now in business.

The truth is that the average tanner has been too conservative for his own interest, but new blood is coming to the front and the change will be beneficial. We see this in the way modern tanneries and currying shops are being built. They are fitted out with all the latest improvements in machinery, the various shops and buildings are of brick and iron, with cement alleys, not a particle of wood being used in their construction. All the buildings are of mill construction, thus lessening their liability to be destroyed by fire, and saving in insurance.

Electric motors should be used to run all machines, as they save fully one-half of the power and thus increase the capacity of the plant, as power is developed only when each machine is in use. They require no line shafts, no heavy belts, pulleys or floor space, the power being conveyed by wire to any part of the beam-house, tannery or currying shop.

Much time is wasted in large tanneries by men running backward and forward to carry messages. Here is where the telephone is now used in leading tanneries, the yards and leach house and other parts of the tannery or currying shop being all connected by telephone.

We only throw out these suggestions to show how rapidly we are moving forward, and there can be no stop to our progress. The new duty of 15 % on hides and calfskins may hurt for the moment, but the injury will not be permanent. One thing we would like to say to all tanners: never put a dirty hide or skin into any kind of tanning liquor; clean it well with a mild solution of borax, 1½ pounds to the 100 gallons of water. It will pay, and then you will be on the road to quick tannage, as you can then use stronger liquors from the start.

CHAPTER XL.

BLEACHING LEATHER; BLUING WHITE LEATHER; BLEACHING SKINS WITH THE HAIR ON.

BLEACHING LEATHER.

CHAMOIS leather generally possesses a quite pronounced yellow color and in this state cannot be dyed delicate shades. But even the best quality of kid prepared by the process of tawing does not show the pure white color required for the production of the most delicate shades of pigeon gray, straw color, etc., and hence, in order to obtain the leather absolutely white, it will frequently be necessary to subject it, previous to dyeing, to a bleaching process.

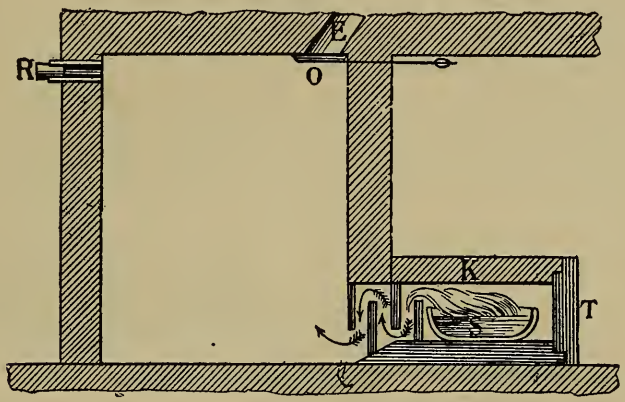
Bleaching is mostly effected with sulphurous acid either in the form of gas, or as a solution of it in water. Sulphurous acid is the product of the combustion of sulphur in the air and is the cause of the suffocating odor evolved thereby.

Formerly leather was bleached by suspending it, in a wet state, in a chamber in which were placed vessels containing sulphur. The chamber was hermetically closed and kept so for twenty-four hours. The gaseous sulphurous acid ascending from the burning sulphur dissolved in the water with which the leather was saturated and effected the bleaching of the latter.

This process, though very simple, has the disadvantage of the bleaching not turning out uniform, and it is therefore to be preferred to effect bleaching by means of a special apparatus, or what is still better, to use a solution of sulphurous acid in water. For the former purpose various apparatuses have been constructed, the general arrangement of which will be understood from the following description and accompanying illus tration:

The bleaching chamber (Fig. 130) consists of a small apartment papered with stout paper and provided with a window opening outward, and which can be hermetically closed. In the ceiling of the apartment is an aperture *O* which can be closed by a slide and communicates with a chimney *E*. Immediately below the ceiling, in another part of the apartment, is fixed a pipe *R* which can be closed by a stopper. Alongside of this apartment is a brick chamber *K* provided with a hermetically closing door *T*, and inside with roofing tiles arranged in the manner shown in the illustration. This

FIG. 130.



chamber communicates with the apartment by an aperture above the floor of the latter.

The leather to be bleached in this apparatus is suspended in a wet state upon poles, so that the separate sides are spread out flat and do not touch one another. The door and window are then hermetically closed, the slide at *O* is opened, and the sulphur in the clay vessel *S*, which stands in the chamber *K*, ignited. The sulphur-vapor carried along with the sulphurous acid evolved by the combustion of the sulphur is condensed on the roofing tiles in the chamber *K*, and the gas thus purified enters the bleaching apartment. The sulphur is allowed to burn until a burning match held in front of the

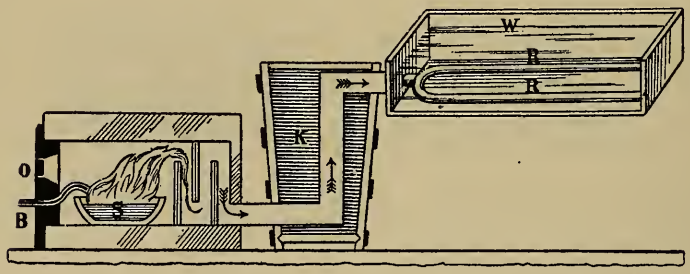
pipe *R* is extinguished. This pipe, as well as the aperture *O* and the door *T* is then closed, whereby the burning sulphur still remaining in the vessel *S* is immediately extinguished. After twelve hours the aperture *O* as well as the doors and windows is opened, the bleached leather is taken out and several times washed in water to remove the last traces of sulphurous acid.

BLEACHING WITH SOLUTION OF SULPHUROUS ACID.

The use of liquid sulphurous acid is far more suitable than the preceding process with gaseous sulphurous acid, the bleaching turning out much better and more uniform. Fig. 131 shows the arrangement of the apparatus for the production of the acid required.

It consists of a brick chamber provided with roofing tiles arranged in the same manner as shown in Fig. 130. Into this chamber enters a pipe *B* which is connected with a pair of

FIG. 131.



bellows. On the other side of the combustion chamber the pipe passes into a forked lead pipe *RR* which is fixed about two inches above the bottom of the shallow wooden vat *W*, and on the lower side is provided with numerous narrow apertures.

The vat *W* is filled six, or at the utmost, eight inches deep with water as cold as possible, and the pipe, which lies in the chamber *K*, is also covered with water. The sulphur in the vessel *S* is then ignited, the door of the chamber *K* (Fig. 131),

which is provided with a pane of glass, closed, and the bellows worked slowly but uninterruptedly.

The sulphur vapors carried along by the sulphurous acid evolved by the combustion of the sulphur are deposited upon the roofing tiles or condensed by the water in the vat *W*. The gas passes out through the narrow apertures of the pipe *RR*, and dissolves abundantly in the cold water. When the water has a strong odor of sulphurous acid and tastes sour, it is sufficiently impregnated with sulphurous acid. The bellows are then stopped and the cock in *S* is closed to prevent water from reaching the combustion apparatus in consequence of the sucking of fluid by the sulphurous acid contained in the cooling pipe.

For bleaching purposes the sulphurous acid thus prepared is brought into small vats of suitable depth, and the wet sides of leather, suspended from poles, are immersed in it, so that they do not touch one another, and allowed to remain about two hours. They are then replaced by a fresh lot, which is allowed to remain for three hours, this being continued until the fluid shows but a very slight odor of sulphurous acid. The leather when taken from the bleaching fluid is immediately washed.

BLEACHING WITH SODIUM PEROXIDE.

Dissolve two pounds of Epsom salts in ten quarts of water, and add gradually to the solution ten ounces of sodium dioxide. Apply the fluid thus obtained to the leather to be bleached. To protect the leather from being injuriously affected by the bleaching agent, it is recommended to moisten the bleached portions with water slightly acidulated with acetic acid.

BLEACHING WITH HYDROGEN PEROXIDE.

Moisten the leather to be bleached with water, to which have been added a few drops of spirit of sal ammoniac, and then apply the hydrogen peroxide with a rag or a brush. Repeat these operations alternately until the leather is sufficiently bleached.

BLEACHING WITH ALUMINIUM HYPOCHLORITE OR MAGNESIUM HYPOCHLORITE.

These bleaching agents are formed by compounding chloride of lime solution respectively with aluminium sulphate solution or with Epsom salt solution. A white precipitate of gypsum is formed, which in a short time deposits completely. The supernatant clear liquor is a very effective bleaching agent, and has the additional advantage of being cheap. It is applied to the leather, and after a few minutes wiped off by means of a wet rag or sponge.

BLEACHING CHAMOIS LEATHER.

Chamois leather cannot be bleached with sulphurous acid alone, and agents of a more vigorously oxidizing action have to be used in order to destroy the adhering coloring matter. For this purpose potassium permanganate may be recommended. Dissolve one part by weight of potassium permanganate in twenty parts by weight of water, spread the leather upon a table, apply the solution and rub it into the leather with a glass ball. During this manipulation the leather becomes constantly darker and finally brown, by reason of the potassium permanganate becoming decomposed and separating manganic oxide, which is of a brown color.

The leather, after being thoroughly worked with the glass ball, is rinsed and immersed in solution of sulphurous acid in water. The manganic oxide dissolves with ease, and the leather, after having been several times washed and finally dried, appears perfectly white.

BLUING WHITE LEATHER.

Kid leather, not pure white, can be made so by bluing. However, the operation has to be executed with great care, so as not to spoil the leather. Dissolve in one hundred quarts of water about three drachms of water-soluble aniline blue. Wash a skin in the solution and dry it. If, after drying, the color is of a too yellow cast, add gradually very small quantities of the dye stuff until the desired tone is ob-

tained. If, on the other hand, the leather is too blue, which is more frequently the case, add ten quarts of water to the bath and repeat this until the desired tone is obtained.

By this simple treatment leather of a quite yellow shade may be obtained pure white, and water-blue leather may also be prepared; in brief, the entire scale of colors between yellowish white and bluish white. It is, however, of importance always to ascertain the strength of the bath by an experiment with a single skin in order not to obtain leather too much blued.

BLEACHING HEAVY LEATHER.

The recipe here given is for bleaching bull's, stag's or russet harness leather:

(1) For 25 sides, put six pounds of borax in five pails of water, so that the leather is entirely covered. Mill for 15 minutes. (2) Dip each side in a strong solution of sulphuric acid (30 degrees), and immediately rinse each side in a vat of clear water. (3) Return the sides to the mill and put in 2½ or say 3 pails of hot strong sumac. Pour in one quart of muriate of tin. Mill for 15 minutes. Take out. Slick off on grain side. Oil evenly over and hang up to sammy, suitable for setting. In setting, blend water with stuffing and stuff lightly over, just enough to lay the flesh smooth. The most important point is to remember to get the tannin out of the liquor before starting in the acids, by giving brisk scouring. For a table set for this bleached leather, cook one pound of starch in two gallons of water and one quart cod oil. If this mixture comes out a trifle heavy reduce with water. It will leave a nice white flesh on leather free from heavy greases. Care must be taken that none of this stuff gets on the grain side. Bleached leather ought to be dried in at least 36 hours; the sooner the better, in order to get a nice uniform color. In bleaching light sides, say four to 6 ounce stock, put 50 hides into the mill.

The following recipe for bleaching leather appeared recently in the *Ricettario del Conbiatoria:* "An interesting product, recently introduced for the bleaching of silk and wool, has been

successfully employed for the bleaching of leather. This agent is the dioxide of sodium. Sold in tin boxes, and having the appearance of powder, it must be kept far from wet and dampness, as it is liable to decompose quickly. When it is required for bleaching leather, the following is the process to be observed: Dissolve by heat two pounds of sulphate of magnesia in nine quarts of water, and when the solution gets cold, gradually add eleven ounces of dioxide of sodium. The leather required to be bleached is rubbed over with this solution until the desired white or clear color is obtained. If the leather to be treated is stout and heavy, the action of the solution may be assisted by first washing the leather with water slightly acidulated with acetic acid."

IMPARTING A LIGHT COLOR TO LEATHER.

Although the tanner will always strive to produce as light colored a leather as possible, since it commands a higher price, still circumstances may occur whereby it is essentially darkened. To correct this he will try to give it a light shade by artificial means, which however, if performed in an incorrect or careless manner, most generally enhances the outward appearance of the leather at the cost of its interior quality. The toning down of dark leather will to a great extent remain a knack of the expert tanner, as long, at least, as there is a provocative cause; in other words, bad tanning material on the one hand, and on the other as long as light colored leather is higher in price than dark, which is in other respects just as good. Since, however, the procedure of artificially toning down the color of the leather is fairly difficult, it may be well to enter into a few details how it is to be done, so as to cause the least injury to its intrinsic quality.

A difference must at first be made between the simple toning down and the direct bleaching. While in the latter procedure the actual color of the leather is to disappear as nearly as possible, to be replaced by a more or less pure white, the aim of the former is to simply modify the dark hue and cause it to

become paler; but it is not the purpose of the process to make the color disappear altogether, which has been recognized to be injurious, and perhaps requires the raising of the color again by artificial means. For this reason actual bleaching agents cannot be used for the simple toning down, or if employed, they are to be applied with the greatest care, so as not to produce a leather white outside but dark within. The agents used for toning down are, as is well known, highly diluted acids, in which the leather is for a time steeped. Best liked because simplest in its application is highly diluted sulphuric acid, or else acetic acid, while with lactic acid mixed with bran, there is danger that the surface of the leather be corroded. While it is undeniable that the toning of the color with these acids is injurious to the quality of the leather, the injury is in large part due to the circumstance that the process is incorrectly conducted. The principal fault lies in entering the more or less dry leather into the water very feebly acidulated with sulphuric acid. The immediate consequence is that the fluid penetrates into the innermost parts of the leather, in other words, saturates it, while as a toning agent it is simply required on the surface. Of course, another advantage is gained thereby, to wit, the leather is toned not only on its surface, but also in its interior, and the fact that it has been subjected to this treatment is not so readily detected. But this process is performed at the expense of the quality of the leather, because this is saturated into its core with sulphuric acid which, though in a highly diluted state, is not very easy to be gotten out again, consequently it can exert its damaging effects at leisure. It would therefore be a great improvement to immerse the leather first in clean soft water, with which it would become saturated, before being entered into the sulphuric acid water. If the leather, already saturated with clean water, is entered into the acidulated water, little or else nothing of it enters into the interior, where it is really not wanted, and where it can simply become injurious, but it remains almost altogether on the surface, where it is wanted for toning the

color. The importance of this modification will at once be apparent to every tanner, and it would also be of interest to the leather trade, because the interior quality of the leather would not suffer by applying the acidulated water on the surface. But here again the objection might be urged that the corrected color, in consequence of the non-penetration of the acid, modifies simply the surface, and the leather thus corrected can be readily distinguished.

TO BLEACH SKINS WITH THE HAIR ON.

The following methods may be employed with advantage for bleaching lamb or goat skins intended for rugs, lap-robes, etc.: A quick bleach is obtained by the use of liquid sulphurous acid, the skins having first been thoroughly freed from grease by washing in lukewarm soapsuds at a temperature of about 82° F. Even more rapid and better results, especially in the bleaching of goatskins, are arrived at with Labarraque's solution (hypochlorite of soda); provided sufficient care is exercised to have the bleaching liquid just strong enough in chloride of sodium and the skins perfectly clean, a snow-white bleach can be obtained inside of two days by this method. The manner of preparing Labarraque's solution is as follows: Mix together 4½ pounds chloride of lime and 21 quarts water, stirring frequently for some time. Leave the mixture standing until thoroughly settled, and then strain off the perfectly clear portion into a solution of 10½ quarts water in which have been dissolved 5½ pounds Glauber salts. An insoluble precipitation of gypsum results, leaving the hypochlorite of soda in solution. The clear liquid, which should be quite free from lime, is next drawn off, and the skins immersed therein until thoroughly bleached, which takes about two days. After removing the skins from the bleaching liquor, rinse well and wash in weak soapsuds prepared of white oil-soap, in order to impart the necessary soft feel.

Small lambskins can be treated satisfactorily by the method employed for bleaching hog bristles, namely, with permangan-

ate of potash and bisulphite of soda. The previously cleansed skins are first immersed and worked for three-quarters of an hour in a bath prepared in the proportion of $1\frac{1}{10}$ pounds crude permanganate of potash to 130 gallons of water, heated to 95° F. At the expiration of the time mentioned they are removed and placed, without rinsing, in a second bath of 130 gallons of water to $7\frac{1}{3}$ quarts bisulphide of 35° Bé, and $6\frac{5}{8}$ pounds hydrochloric acid of 20° Bé, at a temperature of 104° F., in which they are worked until perfectly bleached.

As the question of cost of material and the actual expense of the bleaching process is of secondary importance only, the use of peroxide of hydrogen or peroxide of sodium is to be recommended. Experiments have proved that thoroughly clean lambskins can be bleached beautiful white in a few hours with the first-named chemical. The peroxide of hydrogen is diluted in 8 to 10 times its own weight of water, to which is added a little aqua ammonia, and the skins immersed until the desired result is attained.

CHAPTER XLI.

LACE LEATHER.

LACE leathers are either tanned, tawed, or made from raw hides, and both these varieties as well as picker leathers, which are used for looms, and also for hamestrings, are generally produced in the same tannery. But the variety of lace leather which we shall describe in this chapter is the lighter kind, which is manufactured usually from Calcutta hides, the heavier variety being made from light cow-hides.

When the dry Calcutta hides are used they are first placed to soak in a vat of water, and the time which they remain is dependent upon the weather, one or two nights in warm weather and three or four nights in cold weather being the usual time. The water used for the soaks should be softened with borax, as has been previously described.

They are next softened in the hide-mill, the time which they are worked depending upon the manner in which the hides have been cured.

In order to cleanse them from dirt the hides are next placed in the wash-mill and worked for fifteen or twenty minutes with water softened with borax, which operation also removes the wrinkles.

Upon being removed from the wash-mill, the hides are spread flat upon the floor and slit down the back and thus divided into sides.

They are then placed upon trucks and carried to the lime-vats, where they are spread flat upon the floor alongside the vats and whitewashed, by passing over them a swab which has been dipped in a solution of lime.

This coat of whitewash is applied to the hair side, and the

sides are piled two hundred high, and in warm weather this pack remains over night, but in winter the sides are placed in the lime-vats the same day, in order to prevent the whitewash from chilling. In warm weather the sides remain in the limes about ten days, but in cold weather the period is longer.

It is best to mix sodium sulphide with the lime, as the unhairing is done more quickly and the gelatine of the hide is sound.

When the hair is loosened, the sides are removed from the vats with tongs and immediately unhaired, after which they are placed in water in a vat having a revolving paddle wheel and washed, the England wheel and vat being the one commonly employed, and upon removal are worked on the beam to remove the lime.

They are then fleshed and bated in C. T. bate (manufactured by Martin Dennis Chrome Tannage Co., Newark, N. J.).

As a further preventive against lime the sides are placed in a large revolving wheel, called a "tub wheel," in which they are washed for about three-quarters of an hour, and upon removal from this wheel the sides are placed in the tanning liquors and remain until tanned. When this has been accomplished the sides are exposed to the air to dry and next stretched, a machine for which purpose is shown in Figs. 132 to 134; but the stretching is also performed by hand on the stretch-bench.

As is well known, all hides vary considerably in thickness at different points, and when taken from the liquor-vats they are found to be soft, flabby, wrinkled and fulled. Owing, therefore, to this condition of the hides, it is necessary, before they are dressed and finished for the market, that they be stretched throughout to remove the wrinkles and fulness, and also to reduce those parts which are thicker than other portions, so that, as far as possible, the hides shall be uniform in thickness.

Mechanical devices are capable of producing, in connection with hand manipulation, the desirable results of thoroughly stretching the hides, and rendering them of even thickness in

all parts. These devices usually comprise, in the main, a friction table or beam, over which the hides are dragged, a stretcher-bar of suitable form for stretching the hides transversely, and a slowly-revolving roller, to which the edge of each hide is secured, and around which it is wound after being drawn over the table or beam and the stretcher-bar. After the sides have been well worked on the stretch-bench they are split evenly by the splitting machine.

The sides are next stuffed with tallow and neat's-foot oil, the proportions of which change somewhat according to the temperature and season, less oil and more tallow being used in summer than in winter.

If the tannage is alum or vitriol, stuff in a wheel with the stuffing 90° F. Curriers stuff leather when moist, but figure the material to every 100 pounds of dry leather. They get this weight by deducting one-third from the weight of the sammied leather to be stuffed. Therefore (reckoning on this basis), to 100 pounds of dry lace leather use 10 pounds tallow, 10 pounds degras and 10 pounds cod oil, melted together and put in wheel at 90° F. Time of wheeling depends on tannage and speed of drum. It requires some time to get grease into alum leather. The wheel might have to be run one hour. In a larger wheel shorter time is necessary than in a smaller wheel. In an eight or ten foot drum three-quarters of an hour wheeling ought to suffice, and would keep the leather of a nice color. Grease tends to make tough leather. The heavier the grease the tougher the leather. If more oil is used, leather becomes soft and rather short-fibred. If it were possible to stuff entirely by tallow the leather would be very tough.

The sides are then hung upon sticks in tiers in the drying-room, which is commonly heated by exhaust steam from the engine.

After being removed from the drying-room the sides are softened, the machine shown in Figs. 135 to 143 being now usually employed for this purpose in place of the old-fashioned pin-block.

The sides are next rolled out smoothly on a glassing machine, and then shaved on the flesh side and buffed with a currier's knife, in which latter operation the grain is removed in order to prevent the lacing from cracking; about seventy-five sides being a fair day's work for one man. They are next rubbed with a mixture of lard oil, tallow, and flour, and the sides of lace-leather are then finished by laying them upon a flat table and smoothing them out with a glass slicker.

To obtain the golden yellow color so much desired in lace leather, an old experienced tanner recommends the addition of pulverized brimstone or sulphur to the tanning liquor. The sulphur acts as a tanning agent as well as a colorant. About 2 oz. is the quantity of sulphur requisite to a side. For a darker shade, take 2 oz. japonica instead of sulphur, using it in same manner.

JUNIOR'S METHODS OF MANUFACTURING LACE-LEATHER.

The following process for manufacturing lace-leather is used by Junior, of Belleville, Ill. There is no patent on the process, but Mr. Junior claims one on the tanning compound, which patent has now expired.

The hides in this method go through the following processes:—

First. Soak the hides in fresh water for twenty-four hours.

Second. Soak the hides in freshly slaked lime-water as long as necessary to make the hair removable by scraping.

Third. Put the unhaired hides into fresh lime-water once more for two days.

Fourth. Scrape off all fleshy parts on the inside; then soak the hides in fresh water to free them from all lime.

Fifth. Then rub the hides with a "slick-stone," in order to smooth or burnish them and to squeeze out all impurities.

Sixth. Soak the hides for about twelve hours in warm water, containing one pound of wheat bran and one-half pound of a ferment to every five gallons of water, until the hides cease to swell, and all lime is neutralized.

Seventh. Then squeeze them well with the scrape-iron.

Eighth. Immerse the hides in the composition given below, in which they remain for from twelve to twenty-four hours until they are well saturated.

This composition consists of the following ingredients combined in proportions stated: For every ten pounds of hide—pure water, five gallons; alum, one pound; sal-soda, four ounces; common salt, four ounces; wheat bran (or other bran), four ounces. Of these ingredients the crystalline salts should be thoroughly dissolved and mingled by agitation with the bran. It is claimed that the application in tanning of this solution, in connection with the other treatment of the hides, has the effect of preserving the whole natural strength of the same, which is possible only in the absence of free acids. After the hides have become saturated, they are removed from the solution and hung up to dry.

Ninth. Now work them well on the stretch-bench and split them evenly on the splitting-machine.

Tenth. Rub into the hides a mixture of about three pounds of lard oil and one pound of tallow, and let dry well.

Eleventh. Soak in rain-water containing bran, and in this wet state stretch the hides well on the stretch-bench.

Twelfth. Now shave them as clean as possible on the flesh side, and especially carefully on the grain side, in order to remove the whole grain, which removal produces the elasticity which prevents the liability to cracking.

Thirteenth. Then finally, rub into the hides a mixture of one and one-half pounds of lard oil, one-half pound of tallow, and one-eighth pounds of fine flour for every ten pounds of hide (which process helps to produce smoothness and durability of the leather), let them dry, then stretch and smooth them well with a wooden stretcher, and now the hides are ready for use.

QUICK TANNING PROCESS FOR LACE AND WHIP LEATHER.

The method patented in 1875 by Bartenbach and Richter, of Detroit, Mich., is as follows:

For making lace and whip leather the hides are cleaned after soaking, the hair being removed. Then put them in the following solution, enough being used to fairly submerge them: To twenty-five gallons of warm water add two pounds of alum, fifteen pounds of salt, one pound of sulphuric acid, two pounds of wheat bran, two ounces of dissolved sulphur. The hides are left in this solution for twenty to twenty-five minutes, after which one ounce of vitriol, four pounds of salt, and two ounces of alum, dissolved in one-half gallon of water, are mixed with the solution, and the hides are left to remain in it twenty minutes longer. The hides are then taken out and well wrung, and hung up to dry in a dark, airy place. Those intended for whip leather, when dry, are moistened with a little water, and stretched upon a stretching-iron. Those intended for lacing-leather, after being well dried, are rubbed with a mixture of one pound of fish oil, one pound of tallow, four ounces of linseed oil, and two ounces of soap-soda in a gallon of hot water.

LOESCHER'S METHOD FOR MANUFACTURING LACE LEATHER.

In 1876 H. Loescher, of Chicago, Ill., patented the following method for manufacturing lace leather, the object claimed being to produce lace leather of greater strength and tenacity than that produced by treating skins with lime and acids.

The first step in this process is to remove the hair from the hide by fermentation by subjecting it to a decaying process for a few days. The next step is to dry the skin to a flinty hardness; and the last step consists in subjecting the dried skin to a process of torsion and beating until thoroughly softened, when, it is claimed that it will have the toughness of rawhide, with the pliability of kid.

COUPE'S STRETCHING MACHINE.

The machine for stretching leather shown in Figs. 132 to 134 is the invention of Wm. Coupe, of Attleborough, Mass., who is an extensive manufacturer of lace leather.

Figure 132 represents a front elevation of Coupe's machine.

Fig. 133 shows the same in central vertical transverse section, and Fig. 134 represents the stretcher-bar in perspective.

As particularly shown in Fig. 132, the machine consists of the following devices: A pair of standards as at *A A'*, in which is mounted a shaft, as at *B*, to which power is applied. Upon one

Fig. 132.

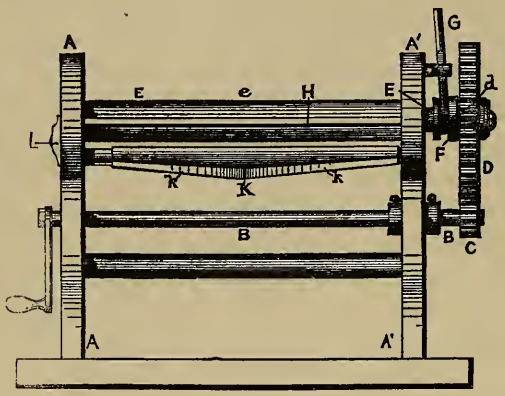


Fig 133.

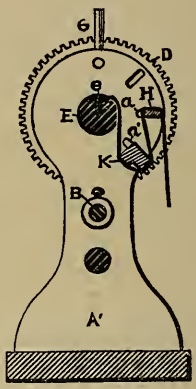
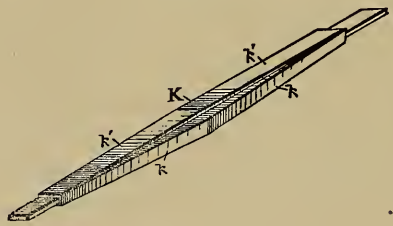


Fig. 134.



end on this shaft is a pinion, as at *C*, arranged to mesh with a gear, as at *D*, loosely mounted on one end of a roller, as at *E*.

The inner side of this gear, *D*, is provided with a clutch face or pin as at *d*, for engagement with a clutch as at *F*, splined to the roller *E*, and furnished with a slipping-handle as at *G*, so arranged as to be convenient of access to the operating attendant. The remaining parts of the machine consist of a narrow table or breast-beam as at *H*, which is mounted in mortises as at *a*, in the standards *A A'*, and a stretcher-bar as

at *K*, likewise mounted-in mortises as at *a'*, and having its two working faces doubly inclined as at *k*, *k'*, Fig. 134.

The operation of the machine is as follows:

A hide is placed over the table or breast-beam, *H*, and one of its ends carried under the stretcher-bar, *K*, and secured to the roller, *E*, by the clamp, *e*, the other end hanging free in front of the machine, as shown in Fig. 133. The operator now connects the roller, *E*, to the continuously-revolving gear, *D*, by means of the handle, *G*, and clutch *F*, and the roller, *E*, slowly revolves, winding the hide around its surface, and drawing it over the friction table or beam, *H*, and around the stretching-bar, *K*.

When any part of the hide, the thickness of which is to be reduced, or the wrinkled or fulled-up portion smoothed out, passes over the table or beam, *H*, the operator who stands in front of the beam applies pressure by hand to the proper portions, thereby increasing the friction between the under surface of the hide and the surface of the bar, *H*, and causing the onward movement of such portions to be retarded. The portions thus pressed upon are more severely stretched than other parts of the hide, and by proper manipulation by the attendant its thickness is rendered uniform, and it passes to the stretching-bar, *K*, in a smooth condition, having been longitudinally stretched upon the beam, *H*.

In passing over the bar, *K*, the hide is transversely stretched by the doubly-inclined sides, *k*, *k'*, from which it passes onward to the roller, *E*, winding about the roller uniformly and smoothly. The machine is now stopped, the hide removed, another secured to the roller, *E*, and the operations above described are repeated.

TIDD'S SOFTENING MACHINE.

Figs. 135 to 143 show the machine invented by J. Tidd, of Woburn, Mass., which is much used for softening lace leather.

Fig. 135 is a side, and Fig. 136 an end elevation. Fig. 137 shows the under side of the cross head *G*. Fig. 138 is a top view of the bed *B*. Fig. 139 is the under side of a grooved

cross-head. Fig. 141 is the top side of a grooved bed. Fig. 143 is a side view of a grooved cross-head, with a corrugated or serpentine rib *l*, instead of the pins *C*. Figs. 140 and 142 are end views of Figs. 139 and 141.

Fig. 135.

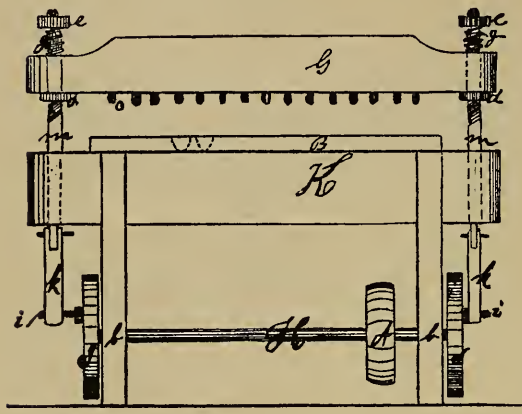


Fig. 136.

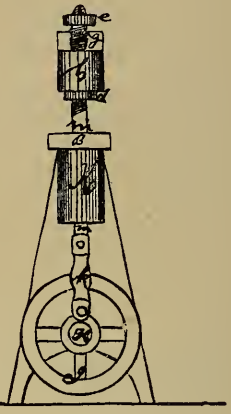


Fig. 137.

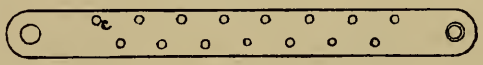


Fig. 138.

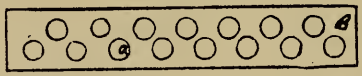


Fig. 139.

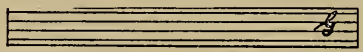


Fig. 140.

The perforated bed *B*, is secured to the top of a supporting-beam *K*, in combination with a yielding cross-head *G*, and a series of pins *c*, projecting downward from the under side. Each perforation *a* in the bed *B* is directly under a corresponding pin in the cross-head. A shaft, *H*, is arranged in bearings at or near the centre, and near the bottom of the framework, and on each end of this shaft is a balance-wheel *I*, outside of the legs *b*, and on the same shaft inside of and near one leg is a pulley

A, to receive the belt which drives the machine. Projecting outward from each of the wheels *I*, are crank-pins or wrist-pins *i*, and the lower end of a pitman, *k*, connects with each pin *i*. The upper end of each pitman connects with the lower end of a vertical rod *m*, which passes freely through a hole in the beam *K*, and extends upward through the cross-head *G*. These rods *m* are screw-threaded from their upper ends downward to a little below the cross-head *G*, and the latter is connected with the rods *m* by nuts *d* beneath the cross-head, and by similar nuts *e* above. The nuts *d* are for raising or lowering the cross-

FIG. 141. FIG. 142.

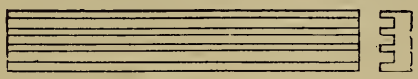
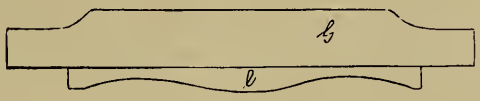


FIG. 143.



head to any desired point of adjustment, and the nuts *e* are to screw down or up, and increase, release, or diminish the action of the springs *g*, which are arranged between the nuts *e* and the upper side of the cross-head *G*, so as to allow the latter to yield when the leather is placed on the perforated bed, beneath the cross-head and the pins *c*, the downward motion of which brings the lower ends of the pins into contact with the leather, pressing, forcing, or bending certain portions of the leather, and in succession other portions, across the edges of the perforation *a*, thereby limbering and softening the leather to the desired degree, or in proportion to the time the leather is moved about between the perforated bed and the pins and cross-head while in motion or action.

Instead of perforated bed and the pins, there are sometimes used a grooved bed and a grooved cross-head, shown in Figs. 139, 140, 141 and 142, and either straight or corrugated or

serpentine horizontally, as in Fig. 141, but the perforated bed and the pins for softening most kinds of leather and hides are preferable, as they require less power, and have a tendency to enlarge the side or piece of leather or hide, by the peculiar operation of the pins and perforations drawing in every direction; whereas, in all previous modes of softening leather, such as pounding the leather with a wooden mallet when spread out on the tops of several pins promiscuously disposed, the leather was considerably contracted or reduced in size, and very imperfectly and unequally softened.

This machine is driven by a belt from some rotating pulley on to the pulley *A*, which rotates the shaft *H* and wheels or cranks *I*, through the medium of which, and the pitman *k* and rods *m*, the cross-head *G* and pins *c* are moved up and down about two hundred strokes per minute. The leather or the hide is moved or fed along over the bed *B*, while the pins *c* strike or press portions of the leather into the perforations, changing from one portion to another until the whole surface of the leather has been acted upon, and the entire side or piece of leather is well and perfectly softened.

CHAPTER XLII.

THE DYEING OF LEATHER.

THE introduction of coal tar colors has given an almost unlimited range of shades and tones and methods of producing them. It is in this very large range that most of the colorist's troubles lie, making it an almost insurmountable difficulty to produce more than one lot of a uniform color. The currier must have a very large experience with the "crankisms" of the various dyestuffs and the conditions which govern their application in order to produce certain colors, and it is here that a knowledge of chemistry combined with keen observation and care will stand him in good stead. The following hints may be of value to him in his efforts to obtain a uniformly colored lot: "The resulting color produced by brushing or dipping a piece of leather in a solution of aniline dye depends (*a*) on the strength of the solution; (*b*) the time of duration of immersion or number of times the solution is brushed over it; (*c*) the temperature of the dye bath; (*d*) the nature of the mordant used before applying the dye; (*e*) nature of the "striker" or "topping agent" applied after the application of the dye; (*f*) the tanning process to which the leather has been subjected, whether hemlock, union, oak, sumac or tawed leather is being dyed; (*g*) the temperature at which dyed leather is dressed, etc.

As is well known, the so-called aniline colors, partly on account of the beauty of their hues, with which they frequently unite a high degree of fastness, seem to be specially adapted for the purpose of leather dyeing, and are, almost all of them, greedily absorbed by, and fixed upon, the leather. For this reason a special mordant is barely ever required for preparing the leather for absorbing a color. It suffices generally to apply

the color directly upon the leather. It may be regarded as a general rule that an aqueous solution is much more readily absorbed, and the shades obtained are much clearer and brighter than when using an aniline soluble only in alcohol, for the very simple reason, because a finer-grade leather with delicate grain cannot well stand the treatment with strong alcoholic solutions. If a dye is to be used which is under no conditions soluble in water, the dyer must at least dilute the alcoholic solution of dyestuff with water to such a degree that the latter will just remain suspended in the liquor. It is self-evident, of course, that the process of dyeing can also with aniline dyes be performed in a manner similar to other dyes—by dipping into the fluid as well as by painting it on; but in a few exceptional cases, it is better to effect the dyeing by painting on the color. Considering their capacity for being toned, the aniline dyes can be applied in almost all light shades of color. The greater part of the yellow, orange, brown and gray dyestuffs are applied by painting, though fuchsine and methyl violet are also applied in this manner. Should the one or the other aniline dye not take uniformly upon the leather, a mordant is to be used. Tanned leather which is rather dark, is best bleached first. This is done by drawing the leather several times through a strong, warm, sumac decoction, or else leaving it immersed in it for a few hours. A priming with picric acid, also to be used in an aqueous solution, is to be recommended for several aniline colors. The dyestuff solutions must be prepared carefully in a suitable state of dilution, which is readily seen by testing upon a piece of glass or white paper.

By the name of mordants the dyer designates a class of agents, the function of which is to prepare a material to be subjected to dyeing to receive, to "fix" the dyestuff upon the latter. According to their action upon a material, the generally used mordants may be divided into three groups, to wit: 1, acids; 2, bases; 3, salts. The bases hold a secondary place in leather dyeing. The most important are: Ammonia, caustic potash, and caustic lime. The important salts used in leather

dyeing are: 1, sulphate of iron; 2, sulphate of copper; 3, sulphate of zinc; 4, sulphate of alumina; 5, alum (a double combination of two sulphates); 6, nitrate of iron; 7, nitrate of lead; 8, chloride of ammonium; 9, chloride of iron; 10, chloride of tin; 11, chlorate of tin; 12, chloride of sodium; 13, acetate of iron; 14, acetate of alumina; 15, acetate of lead; 16, acetate of copper; 17, tartar; 18, carbonate of potash; 19, carbonate of soda; 20, bichromate of potash; 21, chromate of lead; 22, potassium ferro-cyanide, etc.

The most impoatant of the salts are the different soaps, formed by the action of an alkali upon a fat or an oil. A good hard soda soap is in general best for the purpose of leather dyeing, and the only point to be attended to is that it be white and not too strongly alkaline. The best sort is one prepared from olive oil, known in commerce as castile soap, and it is generally used for preparing the leather to absorb the dye-stuff. Before entering upon the actual process of coloring the leather, it is to be assorted according to its color, and destined to be dyed of a hue for which it is best suited. The handsomest skins are used for light brown, lemon yellow, orange, violet, etc. Inferior ones are colored dark green, iron gray and black. It is best to prepare the colors for the occasion, and use them as soon as cold. Let the operator remember in this connection, that if he wishes to produce the possibly best effects, he must observe the greatest cleanliness in all the different stages. The cloth or sieves through which the colors are strained, the vessels for them, the brushes, the tables, all must be kept scrupulously clean. There must be a brush for every color.

Dark Brown.—Eight parts fustic, 1 part logwood, 2 parts Brazil wood, 1 part sanders, one-half part quercitron, are placed in a clean copper boiler, soft water is poured in so that it stands about two inches above the dyewood. The whole is boiled for about one hour, the decoction then strained through linen, and when cold used for dyeing. When the skin has been painted, it is rinsed with cold water while upon the table,

the leather well stretched with a brass slicker, another coat of the dye is applied, again washed off with cold water, and the skin is rubbed until the water runs off clean. Colors that require to be darkened, are washed with a solution of iron vitriol, consisting of 385 to 465 grains Salzburg vitriol * in three quarts of water. This solution is brushed evenly over the skin, and after having been absorbed somewhat, the latter is again washed with clean water, and set aside to dry.

Light Brown.—The above-described color also serves for dyeing light brown, with this difference only, that a dilute potash priming is given and the vitriol bath dispensed with.

Olive Brown.—Two parts, by weight, of Hungarian fustic, 1 part quercitron, and ¼ part logwood are extracted by boiling, and the fluid is then applied upon a strong potash priming, a vitriol bath being subsequently given.

Cutch Brown.—A decoction of 18 ozs. of cutch, with 42 quarts of water and 2.11 ozs. of sulphate of copper, is applied upon the feebly-primed skin.

Chestnut Brown.—The moistened leather is primed with a solution of 2¼ lbs. of acetate of copper in 52 quarts water. It is then rubbed with the slicker, and a coating of yellow prussiate of potash in slightly-acidulated water is applied.

Chocolate Brown.—One and one-half parts Brazil wood are boiled in 45 parts water for two hours, after which a little pyrolignite of iron is added, according to shade.

Red.—A fine red of an admirable shade is produced by a coating with cochineal color, prepared of an optional strength by boiling cochineal in a linen bag in water, to which about 2 per cent. aqua ammonia has been added.

Alizarine Red (a feeble flesh color) is obtained by brushing over the leather a solution of alizarine or madder extract in dilute soda lye, after which rinse with soap water.

Scarlet is produced by painting with Zaffer extract, especially if the leather was previously primed with a feeble annatto

* In chemistry called ferroso-cupric sulphate (mixed iron and copper vitriol).

bottom. The Zaffer extract is diluted with water, in the proportion of about 1 part extract, 60 parts water, 1 part tartar.

Ordinary Red.—An ordinary red is obtained by the decoction of sanders wood upon a feeble priming of alum free from iron.

Dark Green.—Four parts quercitron and 1 part logwood upon a strong priming with vitriol.

Light Olive Green.—Give the leather a light bottom of Prussian blue, and then coat it with a decoction of 2¼ lbs. of fustic and ½ lb. archil in 20 quarts of water.

Picric Green.—The leather primed with Prussian blue is coated with a solution of picric acid in water.

Lemon Yellow.—One part turmeric is digested in 4 parts alcohol at gentle heat for 24 hours, then diluted with water and applied upon a feeble potash bottom.

Barberry Yellow.—Apply a coating with a decoction of 2¼ lbs. of barberry root in 30 parts water, to which 7 ozs. alum free from iron are added.

Orange.—A red priming color is produced with Brazil wood, a yellow with fustic; 75 parts Brazil wood and 25 parts fustic give a red orange; 50 parts of the two an ordinary orange; 25 parts Brazil wood and 75 parts fustic a light orange.

Chrome Yellow.—The dye is first applied with a solution of 1 oz. of red chromate of potash in one pint of water, and is next fixed by 1 oz. of acetate of lead in one pint of water.

In leather dyeing it is the custom to enter the goods at the maximum temperature, viz., about 112° F.; the temperature is not maintained. The goods are turned over by hand in the dye-bath, a pair of skins at a time, care being taken that no single pair shall remain long at the bottom of the pile, from one dozen to three dozen skins, according to size, being dyed together in one bath.

The manufacture of colored leather is a promising field. The tanner who knows how to get out novelties in this line may be sure of success.

There are various methods of dyeing leather, such as the

English method, or the one-tray process; the Continental method, or two-tray process.

The Continental method is approved of, on account of being able to prepare the second tray while the first is in use. The paddle method is not recommended, on account of the waste of dye and liquor, the same applying to the English tray method.

Large paddles or reels are used in the paddle method, in which as many as twenty-five dozen skins or more are dyed in one bath, but a certain amount of coloring matter is wasted by being absorbed on the flesh side of the skins; also the variety of shades obtained is greater, skin for skin, than when the older methods above mentioned are used.

The one great advantage in paddle dyeing is the saving of labor, and it is therefore favored for common classes of goods.

A large number of skins are also dyed by suspending them in a vat, out of which they can be occasionally raised for dripping by a block and tackle.

In dyeing leather, the use of soft, bright, clear water permits the getting of good colors, particularly when bright shades are desired.

Borax is the best agent for softening and brightening water.

Wood dyes possess the advantage of being faster to light, and not so easily rubbed off, and consequently more durable than anilines. They are, however, dearer, and usually require expensive apparatus for their extraction. Aniline colors, on the other hand, are much more easily applied, are cheaper, more brilliant in color, but not fast to a strong light; many fading rapidly.

It is possible to apply alizarine colors to chrome-tanned leather. In order to fix alizarine colors on leather, it is necessary to apply considerable heat; for this reason they are not applicable to ordinary tanned goods. Chrome-tanned leather will, however, stand a high temperature without the slightest damage, and for this reason good results are got with alizarine dyes.

INDIGO CARMINE.

This coloring matter is the product of the action of strong sulphuric acid on indigo, and is of use to the leather manufacturer, making white alums where perfectly white skins are required, giving the same result on this kind of leather as ball or liquid bluing gives to white cotton cloth.

YOUNG FUSTIC.

This coloring matter consists of the wood of the sumac tree, and is the product of Bavaria and Southern France.

Young fustic comes in sticks about six inches long and is cut into chips, the same as logwood or other dyewoods.

This dyewood gives a greenish yellow shade and is used largely by manufacturers of glove leather. It is important that this young fustic should not be confounded with Cuba or so-called old fustic, which is altogether a different article.

EXTRACT OF PEACH WOOD OR RED WOOD.

This is an article which leather manufacturers, to a certain extent, have not given the attention it deserves. For a bottom to be used for dark colors, on mineral tanned, or in fact any tannage, it is a very valuable thing, giving a good base on which to put the aniline; and at the same time it is a saving from the point that, with this base, the amount of aniline to be used is lessened.

CRÈME OF LOGWOOD.

One of the handiest and most reliable of the several articles on the market to replace the chip wood is that sold as crème of logwood, a concentrated, clarified liquor standing 51° Twd., extracted by a new process from the chips in such a way as not to start the tar or resinous matter from the wood, which is found in the general run of extracts, and so sure to make the dyeing liquor dull and muddy. Practical tests have proved this crème of logwood to be as cheap, money value, as the chips, and at all times insuring a uniform dye liquor ready for use at a moment's notice.

This product is especially appreciated by consumers who are situated a long distance from the source of supply, on account of the great saving in freight, etc.

No fixed rule can be laid down for the tanning and coloring of hides and skins. They must be treated according to their nature.

In dyeing it is necessary to use the woods in conjunction with the anilines.

In dyeing leathers with aniline dyes, sumac, bark, or gambier-tanned leathers take neutral dyes, but they can also be dyed with acid dyes.

Alum-tanned leather takes acid dyes.

Chrome tannage takes acid dyes, or must be treated with sumac in order to take neutral dyes, which is usually done.

The chief object in shoe and furniture leather is fastness to light. The basic color of all dyes used for such leather is phosphine, which is fast to light, air, acids and alkalies.

The leather to be dyed should be perfectly clean and free from grease. In order to accomplish this, skins are submitted to a process known as "clearing," which consists in passing them through a weak solution of potash and then through a weak sulphuric acid bath. As there are a great many colors which require sulphuric acid to "set" them on the leather, it is, of course, not necessary to wash the acid out until the dyeing is finished. On the other hand, some colors are very sensitive to the action of the acid, and hence it should be washed carefully out before dyeing with them.

Salable colored leathers must be uniform in color, and this can only be gotten by using pure reliable dyes. Good leather is often spoiled by bad dyes.

WATERPROOF COLORS.

These are prepared as follows, according to a process patented in England by Dimitry: Two ingredients are made use of, one consisting of bichromate of potash, the other of a gelatin solution. These are mixed in suitable proportions and boiled,

after which they are exposed to the sunlight. The mixture is then combined with a watery solution of aniline black, so as to form a thick pigment. It may also be employed with other aniline colors, which in this way become both acid and waterproof.

MORDANTS.

The few minerals which come into practical use in leather dyeing, are bichromate of potash, sulphate of iron, sulphate of alumina, sulphate of copper, and ferrocyanide of potassium.

The first two mentioned are used for producing a dark or sad effect on leather dyed with the aniline colors, or for subduing the fiery tone of the brighter dyes. Sulphate of copper, or as it is commercially known, "blue vitriol," is also used for toning down a color. These three minerals are used either as mordants, or for toning the color after the aniline has been applied.

Sulphate of alumina, or common alum, has exactly the opposite effect, as it has a tendency to sharpen and bring out the brilliancy of most of the anilines. Ferrocyanide of potassium in conjunction with a solution of ferric sulphate, or copperas, produces a most beautiful mordant for any of the blue dyes.

In using a mineral salt as a mordant, care should be taken that the salt in use is properly fixed in the fibre of the skin before the aniline is applied.

It is also advisable to remove any excess of mordanting solution which has not been absorbed by the skin, as the presence of the mineral salt in actual solution may have a deterrent effect on the penetrating qualities of the aniline.

A mordant has served its purpose when it has become a component part of the skin, and the subsequent dyeing will result more satisfactorily if the superfluous mordanting liquor is removed from contact with the aniline.

In dyeing with the aniline colors care should be taken to dissolve the dye thoroughly and in such a manner that no sediment shall remain in the vessel.

The dye should never be applied to the skins until it has been well strained.

It is also well to repeat that uniformity of color can never be obtained where precautions are not taken in regard to cleanliness of vessels, etc., used in preparing the dye, as a vessel which has been used for some other purpose may contain traces of foreign matter sufficient to cause a chemical change in the aniline, which would prevent its going into the leather uniformly.

Evenness of color on the skin can also be facilitated by dividing the given amount of dye to a given weight of leather into 3 or 4 portions; for instance, if 100 lbs. of leather required 3 lbs. amaranth 3/R to produce a desired shade, it would be well to divide the solution into three different vessels and apply the contents of the second vessel as soon as it is apparent that the skins have absorbed the dye from the first, and the third in sequence from the second, and so on.

"TANNERS' PREPARATION" FOR OBTAINING UNIFORM COLORED LEATHER.

The continually increasing popularity of colored leather has engaged the attention of tanners more closely in recent years to perfecting the production of this commodity. Many methods in this connection have from time to time been placed on the market, but the vast majority have eventually proved to be failures, the chief difficulty encountered in the manufacture of salable colored leather apparently being the trouble experienced in successfully mordanting, clearing the grain, and removing all grease and animal matter from the leather prior to its reception of the coloring matter, it being a well-known fact that perfect abstraction of all grease and animal matter is an absolute necessity, if uniformity and clearness of color are to be obtained. How to accomplish this desired result without injuring the leather is the problem which comparatively few tanners have been able to solve with any degree of certainty.

Gilbert Bros. & Co., Nos. 202 and 204 Purchase street, Boston, have recently introduced an article of which they are the manufacturers, designated "Tanners' Preparation," which has

been practically tested and is now being used by many of the most prominent manufacturers of colored leather, both in the United States and abroad, with highly gratifying success in removing the above-mentioned difficulties. The successful production of this "Tanners' Preparation" was only attained after months of experimenting, and by the possession of thoroughly practical knowledge on the subject of mordant treatment of leather by various compound salts and vegetable products, acquired by years of study by the manufacturers.

The process suggested by the manufacturers of this "Tanners' Preparation" is simply that it be used as a mordant for clearing after the skins are tanned, using about one part to fifty parts of water, regardless of the process of coloring or the colors used. Its principal advantages are that it removes all spots, grease and stains, thereby giving an evenness of shade and at the same time effecting a decided saving in the dyestuff.

BLEEDING OR SMUTTING OFF OF COLORS.

The so-called bleeding or smutting off of the colors upon goods dyed causes the greatest annoyances in the dyeing trade, and such effects must always be regarded as indicative of great faults in the application of coloring ingredients, or an injudicious choice of such substances for the respective fabrics treated. These troubles are frequently heard of in dyeing chrome black, and by the use of alizarine dyes. Such accidents were less frequently heard of when wood dyes were in general use, but in any case they can only be attributed to an imperfect handling of the dye stuffs. Some dyers are in the habit of substituting cheaper mordants and reviving agents for those recommended by the dye manufacturers, and even of reducing the necessary manipulations of the goods in order to save time. In such cases, this substitution might prove to have an effect incompatible with the coloring bodies, or the fibrous substances, and in some instances even cause decomposition of the coloring bodies, and prevent their fixing altogether. The mordants and dye stuffs can only upon perfectly clean surfaces be correctly devel-

oped and fixed. If there are noxious foreign bodies present upon the fibrous substance, it can only cause a great waste of dye.

THE PRACTICAL DYEING OF LEATHER WITH ANILINE COLORS.

The accompanying samples were dyed in a practical way and taken from lots put through by the different firms mentioned.

They were done in a practical way and the formulas attached may be relied upon as being correct. The colors used are those that experience has taught us as being particularly adapted for leather, and from which shades can be produced at a reasonable cost. In dissolving aniline colors it is well to have the water heated to about 180° F.; the color added and allowed to go into solution; then bring to boil for several minutes.

Sample No. I.

RUSSIA CALF—COMBINATION TANNAGE.

Tanned and colored by Bernard Freidman & Co., Danvers, Mass.

For 30 feet stock 3 skins, used 3 oz. Leather brown F. Run in pin wheel ½ hour. Color furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. II.

RUSSIA CALF—COMBINATION TANNAGE.

Tanned and colored by E. A. Muller, North Cambridge, Mass.

Ox-blood shade. 5 doz. small calf skins. Run 10 minutes in wheel with 50 gallons water to dampen out and soften leather; temperature 90° F.; then handle as follows:

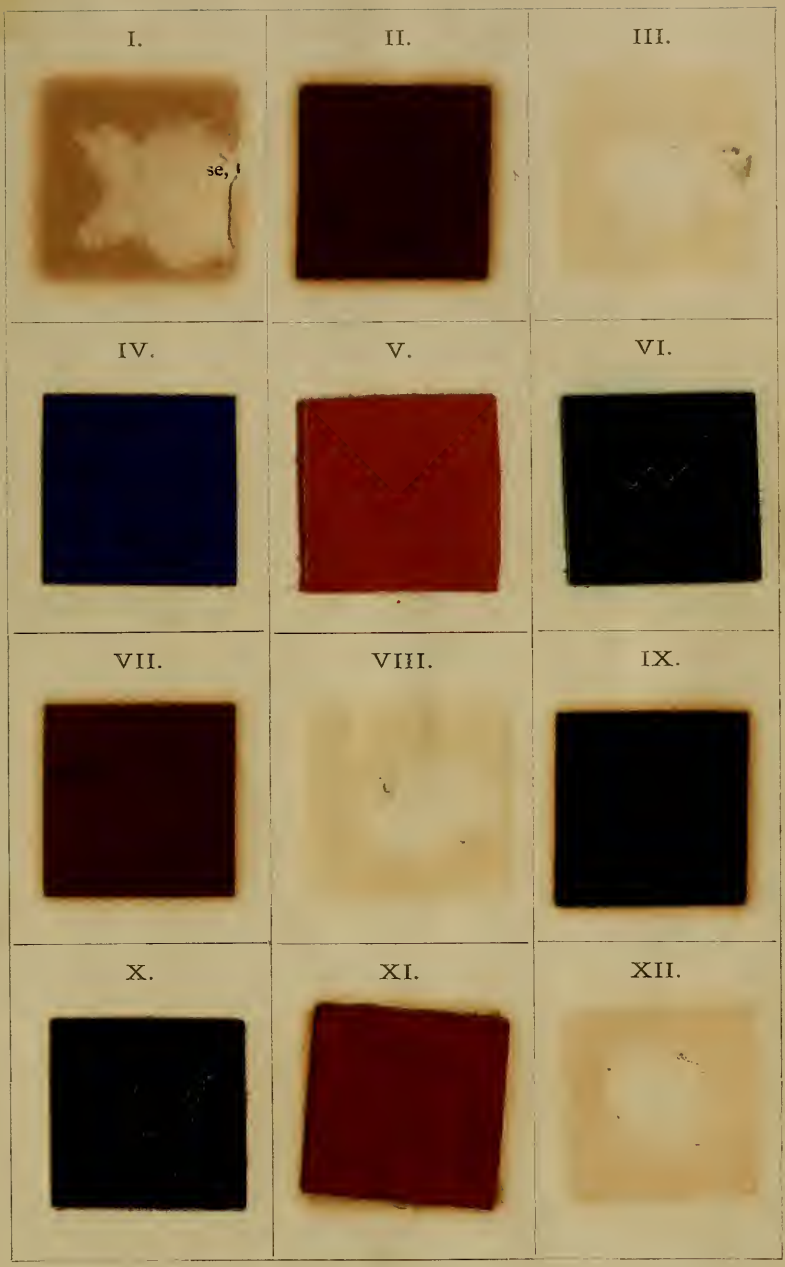
1½ lbs. Tartar Emetic. Run 15 minutes.

2 lbs. Amaranth, 3–R, added in four separate parts. First part run 10 minutes and succeeding ones 15 minutes each.

Then add 12 ozs. Amaranth, 1–R. } Run ½ hour.
" " 4 " Chocolate brown O. }
" " 3 lbs. Palermo fig soap.
" " 5 lbs. pure egg yolk.
" " 5 ozs. bichromate potash.

Add in above order.

Dye furnished by F. E. Atteaux & Co., Boston, Mass.


I.
II.
III.
IV.
V.
VI.
VII.
VIII.
IX.
X.
XI.
XII.

Sample No. III.

CLOVE SHEEP LEATHER—ATTEAUX O. B. MINERAL TAN.

Natural color of the leather as it comes from the tan.
Tanned by F. C. Rose, Gloversville, N. Y.

Sample No. IV.

SHEEP SKIN—SUMAC TANNAGE.

Tanned and colored by A. C. Lawrence & Co., Peabody, Mass.
For large skins 1 oz. leather blue No. 1 to dozen skins.
Color furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. V.

TANNAGE—ATTEAUX O. B. MINERAL TAN.

For 1 dozen pickle sheep, 6 oz. fulling red for leather. Run ½ hour.
Tanned and colored by F. C. Rose, Gloversville, N. Y.
Dye furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. VI.

TANNAGE—ATTEAUX O. B. MINERAL TAN.

For 1 doz. Goat Skins (Russian).
Light bottom pure fustic extracts 51°, run 10 minutes.
3 ozs. dark green M., 1½ ozs. amaranth 1–R., run 15 minutes.
Tanned and colored by Weber Leather Co., Lynn, Mass.
Dye furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. VII.

INDIA TANNED GOAT.

Colored and finished by Donohue Bros., Lynn, Mass.
For 1 doz. skins, cleared in borax and sal soda water, dyed with 4 ozs. nut brown "O," with a very light chrome on top.
Color furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. VIII.

SHEEP

Tanned with the Atteaux O. B. Mineral Tan.
Tanned and colored by F. C. Rose, Gloversville, N. Y.
Colored as follows: 14 doz. skins—2½ lbs. yellow II., 2 lbs. ext. fustic solid.
Fat liquored as follows: A mixture 40 lbs. light English sod oil, 20 lbs. Palermo fig soap, 50 galls. water.
Used ¾ pail of above mixture to each dozen skins.
Dye furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. IX.

DARK GREEN INDIA TANNED GOAT SKIN.

Colored and finished by P. D. Egan, Salem, Mass.

For 1 doz. skins: 1 oz. Bichromate Potash, 10 minutes; 2 ozs. Direct Green "B," 10 minutes; 1 oz. Bichromate Potash, 10 minutes; ½ oz. Copperas, 10 minutes.

Dye furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. X.

PICKLE SHEEP SKIN TANNAGE—TWO BATH CHROME.

Dark ox blood.

For 1 dozen sheepskins. Put skins in 20 gallons water at 110° F. Dissolve 1 lb. fustic extract and 2 lbs. peachwood extract in boiling water. Stir while in water and add above. Run ½ hour. Then dissolve 6 ozs. amaranth 3-R—⅛ oz. malachite green in 1 gallon water. Then add another gallon boiling water and 1 oz. bichromate of potash.

Sample No. XI.

FOR 1 DOZEN SHEEP SKINS—HEMLOCK TANNAGE.

Tanned and colored by Geo. E. Hayes, Peabody, Mass.

4 ounces fulling red. Run 20 minutes. Then add ½ ounce bichromate potash and run 10 minutes longer.

Color furnished by F. E. Atteaux & Co., Boston, Mass.

Sample No. XII.

GOAT SKIN—ATTEAUX, O. B. MINERAL TAN.

Tanned and colored by Weber Leather Co., Lynn, Mass.

For 500 lbs. leather.

5 lbs. pure extract fustic, 51°, 7 minutes.

2 lbs. haematoxylin powder, 7 minutes.

1 lb. 6 oz. anilin yellow, 7 minutes.

13 oz. chrome brown, B, 7 minutes.

4 oz. golden orange, 7 minutes.

12 oz. bichromate potash, 7 minutes.

Before adding each of above they were dissolved in 3 buckets water.

Fat liquor, ½ pail pure egg yolk.

Dye furnished by F. E. Atteaux & Co., Boston, Mass.

The following list of aniline and alizarine colors that work to advantage on leather and are being used in a general way among leather manufacturers. They are furnished by F. E. Atteaux & Co., Boston, Mass.:

Amaranth 1/R.
" 2/R.
" 3/R.
Leather Red 1/B.
" " 3/B.
Safranine.
Eosine.
Fast Red.
Archil Substitute.
Grenat.
Russia Red.
Imperial Red.
Fuchsine F. B.
Maroon for Leather.
Bordeaux Extra.
Blood Red.
Olive 11.
Norwood Olive.
Phloxine.
Violets 1/R to 5/R.
Violets 1/B to 6/B.
Acid Violet.
Malachite Green.
Fast Green.
Brilliant Green.
China Green.
Fmerald Green.
Victoria Green.
Dark Green S.
Pure Blue.
Alizarine Brown O.
" Red W. B.
" Red B.
Diamond Brown M.
Sienna Brown R.
Sienna Brown Y.
Middleton Brown.
Leather Brown, Extra.
Bismarck Brown Y S.
Bismarck Brown R. S.
Mokka Brown.
Cutch Brown.
Dominion Brown.
Terra Cotta Brown.
Mahogany Brown.
Acid Brown R.
Acid Brown B.
Acid Brown G.
Nankin Brown Lumps.
" Brown B S R.
Leather Brown B S R.
Chocolate Brown O.
Chocolate Brown 270.
Brown 361 for Leather.
Olive Brown K.
Seal Brown.
Nankin Brown R.
Leather Brown No. 200.
Methylene Blue.
Guernsey Blue.
Fast Blue.
Gentianine Blue.
Nicholson Blue.
Soluble Blue.
Alizarine Brown Y.
" Orange.
" Violet.
Phosphine.
Yellow 849.
Flesh Yellow.
Sun Yellow.
Azo Yellow.
Leather Yellow A.
Fast Yellow F.
Acid Yellow F.
Mimosa Yellow.
Chrysodine.
Lemon Yellow.
Boston Yellow.
Naphthol Yellow.
Leather Yellow No. 15.
Orange I.
" I I.
" IV.
" D.
Chrome Orange.
Vici Drab.
Bluish Grey.
Silver Grey.
Ink Black.
Acid Black L.
Pure Black.
G G S Black.
Nigrosine P.
Nigrosine Extra.
Nigrosine B.
Indigotine.
Blue No. 444.
Alizarine Yellow.
" Blue.
" Mordant.
Curcumine.
Citronine.
Vesuvine R.

FORMULA FOR OBTAINING THE CORRECT OX-BLOOD SHADE ON COMBINATION TAN OR STRAIGHT GAMBIER TANNED CALF SKINS, FURNISHED BY F. E. ATTEAUX & CO., BOSTON, MASS.

1 dozen calf skins averaging 10 feet each.

Take 10 lbs. hypernic chips; boil thoroughly and strain through cheese cloth or bagging. Put skins in wheel with sufficient warm water (temperature 80° F.) to float them. Add the hypernic solution by degrees while the wheel is in

motion; run wheel ½ hour. Take 7 oz. amaranth 3–R, put it in a clean, dry pail and pour slowly over it a gallon of boiling water; keep stirring all the time. Then hold the pail under a steam pipe and boil thoroughly for 10 minutes; strain through cheese cloth and cool down to 110° F. by adding cold water. Divide this into 3 parts and apply to skins at intervals of 5 minutes, and wheel for 15 minutes after the last portion of the dye went in.

Take the skins out and dip them in a barrel of clean, warm water. Run off the waste dye liquor and wash the wheel out.

Put clean, warm water in wheel (enough to cover the skins), put the skins back in wheel, then dissolve 3 oz. bichromate potash in 2 gallons of hot water and apply to skins while the wheel is in motion. Run wheel 15 minutes.

The color should not fade if you take proper care of the temperature of your liquors. Do not let it get colder than 90° F., and do not go higher than 110° F., or the skins will draw.

It is important that you boil the aniline thoroughly. You will lessen the liability to fade by fat-liquoring your skins immediately after coloring.

Strike them out first to remove surplus water; then fat liquor.

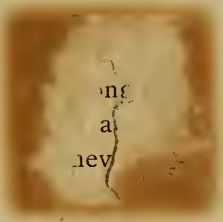
Dry slowly in an even temperature.

Patent phosphine G. G., as shown in the leather sample No. 13, for which we are indebted to A. Klipstein & Co., is one of the most valuable materials for makers of colored leathers, combining, as it does, most unusual fastness to light and durability of shade with moderate cost. This is one of the newest and best of the full line of colors carried by this firm, whose enviable reputation gained by an intimate acquaintance with the leather manufacturers during the past quarter of a century is a guarantee of the reliability of their information in respect to these colors.

Their head office is in New York, with branches at Philadelphia, Boston, Chicago, Providence, Cincinnati and Hamilton, Ont.

XIII.

XIV.



Sample No. 14 is a specimen of quebracho-tanned leather which is also furnished by A. Klipstein & Co., New York.

They are the largest importers of quebracho extract in this country, and carry a large stock at their main warehouse in New York and at their various branches.

The advantages of using quebracho may be summed up as follows:

1. It makes the most pliable leather because
2. It tans all the way through the hide, consequently
3. It increases the weight of leather obtainer.
4. It tans more rapidly, and
5. It tans more denser solutions than any other tanning agent.
6. It is the cheapest tannage known.

CALF LEATHER DYEING.

Calf is among leathers what silk is among textile fibres, for it is readily dyed of all shades. There are, however, certain difficulties which many manufacturers never overcome, and important among these are those which arise from improper preparation of the leather. In small works the preliminary softening is effected by a short soaking in sufficient luke-warm water to cover the leather, followed by an hour's pounding with oak stamps. Water at 104° F. is then run into the vat, and the goods are thoroughly handled for some time; the turbid water is drained off, and the stamping and handling repeated until the right degree of slipperiness has been attained. Tumblers replace the stamps in larger works. After the softening process the leathers are made up into pairs, one leather being stretched grain downwards on a glass or zinc table, and another stretched on the top of this one with the grain upwards; this affords an opportunity for striking out certain blemishes, and is also conducive to economy of dyestuffs, since the flesh sides are not exposed in the dye-bath.

The water for the dye-bath should be acidulated with acetic acid to avoid the hardening effect of calcareous matters on the

leather. For light shades, alum or bichromate of potash are the mordants; for medium tones, a purer acetate of iron is used; whilst pyrolignite of iron (about 15° B.), nitrate of iron (30° B.), or sulphate of iron (30° B.), serve for the darker shades. Alum is but little used. Bichromate of potash is applied to the extent of 10–20 grammes (154.32 to 308.64 grains) per pair of leathers, the whole being generally added at once. The leather is well handled in the bath for 10 minutes, and transferred to a fresh bath, to which a small portion of the dyestuff has been added; into a second fresh bath the remainder of the dyestuff is introduced, and the dyeing is completed therein. If a smaller proportion of bichromate is being used, the dyeing can be completed in the first bath. When iron mordants are used, acetic acid must be present in the mordant bath, and it is advantageous to use the feeblest iron salts for grounding. A dilute iron mordant (the purer acetate at 2° B., or pyrolignite at about 10° B.) saddens gradually, whilst a stronger liquor is very active and "goes quickly on," so that uneven dyeing easily results. Cold-washing after the iron mordant is to be avoided, since the leather is thereby hardened. The foregoing mordants are for basic dyestuffs, acid dyestuffs not being amenable to such treatment.

The following list of leather dyes is given:

BASIC.	ACID.
Auramine.	Quinoline yellow.
Phosphine N.	Naphthol yellow.
Philadelphia yellow.	Curcurmen.
Leather yellow.	India yellow.
Aniline yellow.	Azo acid yellow.
Phosphine P. H.	Orange I I.
New Phosphine.	Mandarin G. extra.
Phosphine superfine.	Ponceau B O. extra.
Thioflavine T.	Ponceau 3 R B.
Xanthine.	Scarlet for leather.
Canelle.	Ponceau B extra.
Leather red.	Pure blue.
Grenadine.	China blue.
Camelia B.	Bavarian blue.

Russia-leather red.
Bismarck brown.
Manchester brown P S.
Vesuvine.
Cachou brown D.
Leather brown A and B.
Malachite green.
Diamond green.
Methylene blue.
Methylene dark blue B R.
Coal black.
Leather black.
Leather black 4252.
Fast blue for leather.
Acid green.
Guinea green.
Fast brown O.
Fast brown 3 B.
Eosin.
Erythrosin.
Phloxin.
Rhodamine.
Nigrosin.

THE DYEING OF LEATHER FOR SHOES.

A largely increased demand for brown shoe leather has been evident for the last few years. Leather for this purpose is manufactured principally from calf skin for the better article, and from sheep skin for the inferior. Sheep skins already tanned are largely imported from Australia and New Zealand into England. The tanning agent in this case is the bark of the various species of acacia, natives of Australia, which contain the deep red mimotannic acid, and consequently the tannage is of a reddish tint. These skins are capable of being dyed really beautiful colors, and when carefully dyed and finished the better qualities make a fine article at a comparatively low price, but, of course, with nothing like the resistance to wear of a calf skin. The process for preparing tanned calf skins for dyeing is as follows: During the tanning process a large quantity of ellagic acid is almost invariably precipitated, and intimately mixed with the fibres of the skin. This is technically known as bloom, and must be removed before dyeing, or very poor uneven shades will result.

Previous to this operation the goods are shaved down to the required substance. They should then be tumbled with warm water in a revolving drum to break and soften them, and this operation also removes a portion of the bloom. The skins are next taken out one at a time and placed on a marble or glass slab, each skin being knocked out perfectly flat and level so

that it attaches itself, as it were, to the slab This is done by the men with what is known as a brass slicker. With this tool the grain of the skin is pushed out smooth until it presents an even surface. The grain of the skin is now scoured with a sort of brush made by tying up a piece of brass into a suitable shape; by this process and a repetition of the slicking out the bloom is removed from the skin. The skins are next worked in a warm and very weak solution of soda crystals to remove surface grease. They are then taken to a bath of sulphuric acid of about $\frac{3}{4}$ per cent. strength and worked about in this for ten minutes, after which they are knocked about in running fresh water until they no longer taste of acid, or if to be dyed with acid coloring matters, only slightly so. After draining on a horse or trestle for some time the skins are slicked out on the grain side until they present an even surface; they are then placed flesh side together in pairs ready for the dye-bath.

Dyeing Calf Skins for Shoe Work.—It will readily be seen from the great difference in weight of similar-sized skins and by the fact that only the grain side of the skin must necessarily be dyed, that it is impossible to calculate percentages of coloring matter simply to weight of skins. One must perforce use different percentages for different classes and sizes of skins, also for different tannages; the correct proportions for different tannages, etc., being only learned by experience. The acid coloring matters are so easily applied to leather and the results are so satisfactory, that they are to a large extent replacing other classes of coloring matters.

With the following three colors almost any shade of brown which will be required for shoe purposes may be obtained, viz.: Azo flavine RS, fast brown, blue black (induline).

For instance, by combination of eight parts azo flavine and half part fast brown, the light Russian brown shade, which is so much worn, may be produced.

Four parts azo flavine, one part fast brown and half part blue black will produce a medium shade of brown.

Four parts azo flavine and two parts fast brown produce a red brown.

To produce a chocolate or dark brown, one part blue black and one part fast brown are applied to the skins, four parts azo flavine and one part fast brown being afterwards added to the same bath.

The varieties of colored leather used for shoes are becoming more marked each year. From solemn black to sober brown was the first step, and then the browns grew lighter and lighter until they reached the custard tint. After the browns came the reds and the ox-blood tints were the thing, and now we are drifting into blue and green tints foi ladies' shoes. These fancy colors all make money while novel, but they are liable to go out of fashion any day. However the bold spirits who are able to furnish promptly whatever colored leather is wanted will make the money if agile enough to return to beaten paths at the right time.

DIRECTIONS FOR OBTAINING CORRECT OX-BLOOD SHADE ON ONE DOZEN CHROME TANNED CALFSKINS.

The following instructions are given by F. E. Atteaux & Co., the well-known dye-stuff house of Boston, Mass.:

Dissolve 1 lb. extract of fustic and 2 lbs. extract of peachwood in boiling water. Put skins in the wheel with 30 gallons of water, temperature 110° F.; stir while in motion and add above decoction by degrees, either through open door of wheel or through funnel attached to journal bearings of wheel. Run for half hour. Then dissolve in bucket 12 ozs. amaranth 3/R with 1 gallon boiling water and add 8 ozs. white glycerine; stir constantly while adding boiling water and glycerine. Then add another gallon of boiling water and hold pail under steam pipe, stirring all the time until the aniline is thoroughly dissolved.

Have another bucket ready, over the top of which is spread a piece of cheese-cloth or fine bagging, and allow this mixture to run through the screen. Then cool off with cold water to 110° F. and apply same to skins in wheel in the same manner as the preparation first mentioned, doing this while the wheel

is in motion. Run them half hour, then take out skins and dip separately in barrel of clean water. Run off waste dye-liquor and wash wheel out. Dissolve 2 ozs. bichromate of potash in water and add to skins as the other liquors were added. Run wheel for fifteen minutes, then take skins out and lay away grain to grain for half hour before striking out. In setting grain use brass slickers.

Note.—Do not at any time during the operation allow the temperature of the water in the wheel to fall below 100° F.

Do not stop the wheel under any circumstances until the dye has been in for at least ten minutes.

Be sure all utensils are perfectly clean.

Shade of color desired is a matter of judgment. A greater depth of color can be obtained by increasing the strength of the mordant or the first liquor as described above.

For a light shade of ox-blood, increase the proportion of fustic extract and use less of the peachwood.

If sumac extract be used for a mordant in place of the one we have mentioned above, use 1 lb. of the extract to 1 dozen calfskins.

All dye, etc., should be thoroughly boiled and should be cooled with water before being put in the wheel.

It is of the greatest importance to keep the skins in motion while adding any of the dyeing material.

METHODS OF DYEING LEATHER USED IN GERMANY—PREPARING THE DYE BATH.

When a leather has been mordanted with a mordant of determined concentration, a certain quantity of mordant is present upon a definite surface of the leather, for instance upon a square inch, and with the proper use of the mordant this proportion is the same upon the entire surface of the leather, i. e., each surface of one square inch contains the same amount of mordant.

However, a determined quantity of the mordant will also fix a definite quantity of coloring matter and with a uniform distri-

bution of the mordant over the entire surface of the leather the intensity of the color will be alike everywhere.

Hence it will be seen that the depth of a certain color is dependent on the quantity of mordant present upon a definite surface; i. e., if a mordant of determined concentration is applied to the surface, the result of dyeing will be a certain definite shade of the respective colors. With a mordant of greater concentration the result will be a darker shade of the same color, while with a more dilute mordant a lighter shade of the same color will be obtained.

When working with a substantive coloring matter, i. e., a coloring matter which combines with the fibre of the leather without the necessity of using a mordant, a saturated solution will give the darkest tone the respective coloring matter is capable of producing, and, on the other hand, the more the solutions are diluted the lighter the shades will be.

It is well known that in dyeing leather, and especially in dyeing kid, such advancement has been made that with one and the same color, for instance, pigeon gray or fawn, such numerous modifications may be produced that by laying the dyed leathers alongside one another, a complete scale of colors, from the most delicate gray or light brown to the darkest gray or brown, may be established.

Now in order not to work at hap-hazard and not to make the hitting of a certain desired color dependent on the skill of the workman, it is of importance to find means by which the shades to be produced may once for all be fixed.

If, for instance, a color is to be produced which is to be formed by fixing the coloring matter of a wood upon the leather by means of tin oxide or alumina, a definite tone of color may be obtained by working according to one or the other of the following processes:

A mordant of tin-salt containing an accurately determined quantity of tin-salt is prepared as follows: Dissolve an accurately weighed quantity of the salt in water, and apportion this quantity to a corresponding number of skins. Instead of

directly weighing, the content of tin-salt in the mordant might also be determined by means of an areometer.

Now, theoretically, with the use of a solution containing an accurately determined quantity of tin-salt a definite tone of color should be formed, but in the practice it is, for several reasons, scarcely possible to obtain satisfactory results by this method.

On the one hand, it is not so easy as it would appear at the first glance, always to weigh with the utmost accuracy the same quantities of a body, or to determine with positive exactness the density of a solution, as is absolutely necessary in this case, while on the other, the skins to be treated are not all of the same size, and even if worked alike their power of absorbing fluids may vary. Furthermore it must be taken into consideration that tawed leather already contains a body, alumina, which possesses the property of fixing coloring matters, and that the animal skin, even in the form of leather, is capable of separating certain quantities of coloring matters, though not substantive ones, which it retains so tenaciously that they cannot be removed even by long-continued washing. Hence with the use of mordants, the content of tin-salt of which has been accurately determined, quite definite tones cannot be produced with absolute certainty, there being many difficulties in the way of the practical execution of this method, though theoretically it is correct.

The other method consists in using solutions of coloring matters of an exactly determined concentration. In this manner it is certainly possible to obtain satisfactory results, the process having besides the advantage of being suitable for substantive colors as well as for colors which can only be fixed by a mordant. This process is based upon the fact that a fluid is capable of dissolving only a certain, exactly determined, quantity of a body.

By boiling, for instance, Brazil wood in water, a certain quantity of the coloring matter is dissolved, but afterwards no more will pass into solution even if boiling be continued for

any length of time. Such a solution is saturated, and in this case is called a hot saturated solution.

By cooling a hot-saturated solution to the ordinary temperature, a certain quantity of the body held in solution re-separates, and we have then what is called a cold-saturated solution. The ordinary temperature of living rooms is about 60° to 65° F., and it may be assumed that within these temperatures a cold-saturated solution of coloring matter in water, which has been prepared by boiling and then allowed to cool, always contains the same quantities of coloring matter.

Hence, by preparing a decoction of a coloring matter and allowing it to cool to the ordinary temperature, a dye-bath is obtained which always contains the same quantities of coloring matter. By dyeing mordanted leather in this dye-bath, which may be used cold or warm, the same shade of color is always obtained.

Now, it is not difficult to prepare, with the assistance of such cold saturated dye-bath, fluids which produce determined lighter shades of color, it being only necessary for this purpose to dilute the bath according to a definite system.

Dilution is best effected by preparing the dye-bath according to 100 parts. By adding to 95 quarts dye-bath 5 quarts water, a bath is obtained which contains $\frac{1}{20}$ less coloring matter than the original cold saturated solution; by adding to 90 quarts dye-bath 10 quarts water, a bath is obtained which contains $\frac{2}{20}$ less coloring matter, and so on. Hence, in this manner, by mixing 95, 90, 85, 80, etc., quarts of dye-bath with 5, 10, 15, 20, etc., quarts of water, baths are obtained, the amount of coloring matter of which decreases according to a certain proportion, and in dyeing these fluids will yield definite tones of color.

By dyeing with such fluids a sample scale of leather, it can be immediately ascertained by comparison in what proportion the dye-bath has to be diluted for the production of a certain shade according to sample. By the use of such a systematically arranged color-scale beautiful results are readily obtained

when coloring matters by themselves are used for dyeing a leather, the matter being, however, more difficult with blended colors which are not produced by one coloring matter alone. However, even in this case it will not be difficult for the experienced workman when a dyed sample is submitted to him to select the coloring matters required for the production of the respective color. With a mixture of solutions prepared in accordance with the method given above he may make an experiment, and from the shade obtained he will at once know whether he has hit the proper proportion or whether there is too much of one or the other coloring matter, and in most cases scarcely more than two trials will be required in order to imitate even the most difficult colors.

When working with ready-made dye-stuffs, for instance aniline colors, it is best, on account of their great coloring power, not to prepare the standard fluids in the above-described manner by making a saturated solution in water and then diluting the solution. A solution of water-soluble blue prepared in that manner would, for instance, appear black, and require enormous quantities of water for dilution to make a fluid suitable for dyeing. For this reason it is preferable to weigh out, according to the coloring power of the dye-stuff, a certain quantity of it, say, 0.1, 0.3, 0.7, and so on, to 3 ounces, and dissolve this quantity in 1 quart of water. Mark the solution thus obtained with 100, as being the most powerful color, and mix $\frac{1}{20}$, $\frac{2}{20}$, $\frac{3}{20}$, and so on, quart of it with $\frac{19}{20}$, $\frac{18}{20}$, $\frac{17}{20}$, and so on, quart of water.

TONING FLUIDS.

In many dyeing establishments it is customary to treat the leathers, after the application of the mordants, with solutions of copperas, sulphate of zinc or sulphate of copper, or of alum, potassium chromate, etc. This operation may suitably be called toning the colors, and the fluids used for the purpose, toning fluids.

The mode of action of the toning fluids varies much accord-

ing to the constitution of the leather and the coloring matter used, and in certain cases may be designated as the actual development of the color itself, while in others it simply causes a corresponding change in the constitution of the tone of color. It may here be remarked that colors produced with the use of aniline colors alone, do not require toning.

If, for instance, a leather has been treated with logwood decoction, only a pale gray-blue coloration is obtained, the blue-black color appearing only after pouring copperas solution over the leather. In this case it may be said that the toning fluid exerts a dyeing action, and it might also be designated as a developing fluid.

A toning fluid consisting of potassium chromate solution acts in a similar manner, a deep black being immediately produced when applied to leather dyed with logwood. If tanned leather be brought in contact with a fluid containing copperas, it is immediately colored bluish-blackish and, with the use of more concentrated copperas solution, even deep black, the reason for this being that the copperas forms a black combination with the tannin. Hence copperas can be used as toning fluid upon tanned leather, or upon leather dyed with color containing tannin when very dark, nearly black tones are to be produced. Moreover, it may here be remarked that every color, no matter with what toning fluid it may be treated, becomes darker in consequence of such treatment. Alum solution when used as a toning fluid, however, is to a certain extent an exception, since it serves the purpose of fixing upon the surface of the leather any non-fixed coloring matter present. Regarding the toning fluids in general, it may be remarked that great care must be observed in using them in their more concentrated state, otherwise the resulting tones will be too dark.

Toning fluids may be prepared in the following proportions:

No. 1.	Alum	2.5
	Water	100.

No. 2.	Alum	5.
	Water	100.
No. 1.	Copperas	1.
	Water	100.
No. 2.	Copperas	1.
	Water	100.
No. 3.	Copperas	3.
	Water	100.
No. 4.	Copperas	4.
	Water	100.

Remarks: No. 3 serves for deep gray and black-blue, No. 4 exclusively for black.

No. 1.	Sulphate of copper	1.
	Water	100.
No. 2.	Sulphate of copper	2.
	Water	100.
No. 3.	Sulphate of copper	3.
	Water	100.
No. 1.	Sulphate of zinc	2.5
	Water	100.
No. 1.	Potassium chromate	0.5
	Water	100.

Remarks: The latter fluid only for logwood and black.

THE COLOR MIXTURES.

On account of the variations in the chemical constitution of the different kinds of leather, the color-mixtures used in dyeing must be different for every variety of leather, and we will here give the most important directions regarding the respective proportions for the different kinds of leather.

Genuine Russia Leather.—This leather is generally dyed only two colors, either black or red.

Black is produced by mordanting with alum and copperas, and subsequent treatment with logwood decoction.

Red is produced by mordanting with alum and subsequent application of decoction of sanders wood. The result of this treatment is a quite pure bright red. If the color is to have a brown tinge, decoction of logwood may to a limited extent be used, together with decoction of sanders wood.

Russia leather for articles of luxury may be dyed every desired color with aniline colors, with the exception of the delicate and pale tones, which demand the presence of a white basis.

Morocco Leather.—The following dye-stuffs are used for the old style of sumac tanned morocco leather—the colors would not answer for the modern kid leather unless it be first mordanted with a warm solution of sumac:

For yellow: Barberries, fustic, or French berries (berries of Avignon).

For orange: Equal parts of decoction of brazil wood and fustic, and for toning after the first dyeing with decoction of barberries in larger or smaller quantities of alum.

For red: Decoction of brazil wood only.

For green: Yellow, according to one of the previously given methods, and upon this blue according to the following process:

For blue: Indigo (soluble), soluble Berlin blue, or Berlin blue from yellow prussiate of potash and ferric oxide.

For brown: Logwood and toning with copperas and alum.

For black: Logwood, a small quantity of fustic and copperas.

Cordovan Leather.—The principal colors of this leather as found in commerce are yellow, red and black. It is dyed as follows:

Yellow: With French berries and alum.

Red: With kermis grains and alum.

Black: With logwood and copperas.

Chamois Leather.—This leather, when bleached with sulphurous acid, is dyed like tanned leather. If not bleached with sulphurous acid it is simply colored rather in a mechanical than chemical way, for instance, by rubbing in whiting, ochre, as well as chrome yellow and reddle. For black, decoction of gall-nuts is used and afterwards acetate of iron.

Tawed Leather.—On account of its white color and its content of alum, which does not exert an injurious effect upon the most delicate shade, this leather can be dyed almost any color. The dyeing of tawed leather has been greatly simplified by the extraordinary beauty of the aniline colors and the facility with

which they adhere to the leather, it being only necessary to prepare a solution of proper concentration of the dye-stuff. However, for certain undecided colors, especially for the various grays, browns and brown-greens, the aniline colors are not very suitable, although the respective tones may be produced with them. We will, therefore, briefly mention the dyestuffs required for dyeing tawed leather according to the old method.

For yellow: Barberries, fustic, chrome yellow, for delicate yellow also weld. However, at present, picric acid is most frequently used, and with it, according to the concentration of the solution, every shade of yellow can be produced.

For red: For dark red, brazil wood in concentrated form and alum toning fluid; for lighter shades to delicate, rosewood, dilute decoction of brazil wood, as well as cochineal. At present a fine quality of fuchsin is most frequently used for delicate red.

For green: Yellow as above, and blue. For the pure color alone aniline green is now frequently used and besides for broken green, logwood. Pale green (water green, Nile green) is produced with soluble indigo and picric acid.

For blue: Soluble indigo, Berlin blue from yellow prussiate of potash and copperas.

For violet: Red as above and soluble indigo; or directly methyl violet or for broken violet fuchsin and logwood.

For brown: Logwood, Brazil wood and fustic in various mixtures.

For gray: The same dyestuffs as for browns, only in different proportions.

For black: Logwood (with or without Brazil wood) and potassium chromate or copperas (also acetate of iron).

For all the dye-stuffs mentioned above the aniline colors offer the best substitute. It is, however, by no means necessary to provide the numerous preparations which are found in commerce under all kinds of names, and generally are nothing else but a well-known color under a new name.

From the dye-stuffs above mentioned all the colors required, especially in dyeing kid, can be readily compounded. However, in buying the dye-stuffs care should be taken to select the finest qualities, even if comparatively dear, since actually pure tones can only be obtained with them. The correctness of this advice can be readily proved. There occurs in commerce, for instance, a fuchsin or an aniline violet which is much cheaper than other preparations of the same kind, and in a solid state as well as in concentrated solution shows no apparent differences from the better qualities; both the cheap as well as the more expensive dye-stuff yielding beautiful red or violet solutions.

In making, however, a dyeing test with both preparations, the difference becomes immediately apparent, the more expensive fuchsin yielding a pure fiery red, while with the cheaper article it is impossible to obtain the same result, the tones always appearing veiled with yellow or brown admixtures. The two kinds of violet behave the same way in dyeing. The cause of this phenomenon is found in the fact that the cheap preparations have not been freed by recrystallization from admixed products which have been formed, besides the actual coloring matter, in the preparation of the fuchsin or violet, and these products possessing also the power of dyeing exert an injurious effect upon the pure color. With the extraordinary dyeing power of the aniline colors it would be false economy to buy the cheaper qualities, since it is impossible to obtain with them pure colors.

The most important dyes of the group of the aniline colors are picric acid, fuchsin, water-soluble blue, methyl violet and iodine green.

For pure colors without toning, the above mentioned colors are used by themselves, and by suitably diluting the solutions the strongest colors may be produced, as well as those which, like a breath, simply modified the white basis color of the leather to yellowish, reddish, bluish, etc.

For colors which are formed by mixing two coloring matters,

mixtures of the solutions of these coloring matters can be directly employed. Thus for orange, picric acid and fuchsin are used, for green, picric acid and soluble blue, for violet, fuchsin and soluble blue, and by allowing one or the other coloring matter to predominate, various shades of the respective mixed color may be obtained.

Since the blended colors, brown and gray, may also be compounded from the three primary colors, yellow, red and blue, and the latter in their greatest purity are represented among the aniline colors by picric acid, fuchsin and water-soluble blue, the blended may also be prepared by mixing these three primary colors. With the assistance of aniline salts, pure black may also be produced, and hence it may be said that in an establishment in which aniline colors are exclusively used, all tones of colors can be obtained which otherwise are produced with the aid of the various coloring matters of vegetable and animal origin.

In many establishments for dyeing leather it is customary to use aniline colors besides coloring matters obtained from woods or other vegetable substances, the aniline colors for economical reasons being, as a rule, employed only for brightening the colors. By taking, however, into consideration the cost of the coloring matters and the extra labor involved, it will readily be seen that dyeing with aniline colors is not more expensive, so that it may also be recommended from this point of view.

PREPARATION OF THE LEATHER FOR DYEING.

The leather to be dyed must be carefully inspected and sorted, since every kind of leather cannot in the same manner be used for dyeing. Leather which is not of uniform density does not take the dye in a uniform manner, and no matter how carefully the work may have been done, the product will turn out spotted or cloudy. For sorting the leather to be dyed, practical experience is of the utmost importance. The workmen entrusted with the work must know, without much hesitation, by the feel and appearance of the skins, what is to be done with them as regards dyeing.

SORTING.

The principal point to be observed in sorting morocco and cordovan leather for dyeing is uniformity and softness of the skins. Very light colors are not applied to these varieties of leather. In sorting chamois leather which is to be dyed, the skins distinguished by special uniformity are also selected.

The most difficult task is the sorting of tawed leather, especially the small skins intended for glacé leather. It is, for instance, well known that gloves the color of which shows very slight defects are thrown out as seconds, and the dyer who does not desire to produce a large quantity of them must learn to avoid even very small blemishes.

Leather which when dyed delicate colors would give many seconds, may, however, be utilized for dark colors, but the latter must be the darker the more pronounced the defects are. In sorting it is, therefore, best to separate the skins into several classes and dye accordingly.

The first class might comprise the leather which is not to be dyed, but intended to be worked into white ball-gloves. Beside a very fine and smooth grain, this leather must be distinguished by special softness and pliability. Such skins are simply bleached, if necessary blued, and mechanically worked to impart to them uniform thickness and luster.

The second class might embrace the leather which besides possessing softness and pliability, is perfectly free from blemishes. Such leather is used for the most delicate colors, such as straw yellow, pearl gray, pale brown, as well as for blue with aniline colors.

The third class might comprise the leather which shows such small defects as might be very prominent with light colors, but disappear with darker colors. Such skins are dyed dark gray, dark brown, but especially blended colors, such as date color, olive green, etc.

The fourth class might include leather with more serious defects than the foregoing, and the grain side of which is not

quite smooth, but which nevertheless possesses softness and pliability. Such leather is, as a rule, dyed black.

Finally, the fifth class might embrace the leather which shows grave defects and an uneven grain, less pliability, and a non-uniform thickness. Such leather is always dyed black. It is seldom worked into gloves, but chiefly utilized as fine shoe leather.

WASHING THE SKINS.

In the subsequent operation to which the sorted skins are subjected, it is advisable to handle at the same time only skins belonging to the same class, since in consequence of their uniformity they behave, as will be readily understood, in the same manner throughout these operations, whereby the work is essentially facilitated.

The first operation which actually belongs to the preparation of the skins is washing. The chief object of washing tanned skins is to remove mechanically adhering dust, to dissolve an excess of tannin which is not firmly fixed upon the fiber, and uniformly to moisten the skins so that in the subsequent mordanting and dyeing, the mordant as well as the dyeing liquid can penetrate to a certain depth into the leather, thus making the color more solid and more durable. The skins to be cleansed are first spread smoothly on a table, which should be perfectly level, and treated with wet brushes. They are then placed in water of 68° to 77° F., and allowed to remain a few hours until the water has acquired a brownish color from the dissolved substances. The skins are then transferred to clean water, in which they remain until they have acquired the proper degree of softness. They are then taken out and, when quite dry on the surface, subjected to the operations of mordanting and dyeing.

Much greater care has to be exercised in washing tawed leather which is to be worked for glacé leather. Small particles of the alum and of the nourishing paste used in tawing adhere to the surface of the skins and are also imbedded in the pores.

We know that alum possesses the property of fixing coloring matters. Now if some portions of the skin have retained more alum than others, more coloring matter will be precipitated there and the dyeing will not turn out uniform all over. By examining with the microscope colored leather not sufficiently washed previous to dyeing, a number of darker spots due to a heavier fixation of coloring matter on the places richer in alum will be plainly seen.

According to the opinion of many dyers the object of washing is to remove as much alum as possible from the leather. However, in our opinion this idea is not correct, since the unavoidable consequence of the partial extraction of tawing matter would be that the outer portions of the leather thus treated would, in drying, shrink in a different manner from the interior portions from which the tawing matter has not been withdrawn, and the leather would not acquire the beautiful luster of leather not subjected to this treatment. It may here be remarked that this error can never be entirely corrected by the subsequent treatment with nourishing paste. Hence the leather should only be washed sufficiently to remove any excess of alum. It can then be readily and uniformly dyed and without trouble be converted into actual glacé leather, i. e., leather with great luster.

For washing lukewarm water is used, a number of skins to be dyed—30 to 50 dozen—being generally treated at one time. To assure uniform moistening of all the skins it is best to use a large vat. One skin after the other is then immersed in the water, moved to and fro, and spread out smoothly on the bottom of the vat.

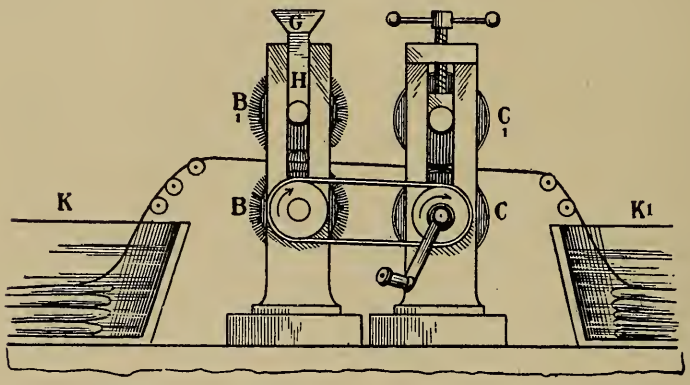
For the uniform and vigorous washing of the skins it is necessary to subject them to a certain mechanical pressure, and it is generally done by workmen treading them with their bare feet. It will be readily understood that the process is quite primitive and, as manual labor has to be used, also quite expensive. However, notwithstanding these drawbacks, which are perfectly understood by most dyers, many of them assert

that the treading of the skins cannot be replaced by any other method of manipulation, and that only in this manner can the skins be prepared for uniform dyeing.

THE WASHING MACHINE.

The above-mentioned assertion is, however, incorrect, since the work of washing and proper manipulation may be executed with the assistance of mechanical appliances, the arrangement shown in Fig. 144 being well adapted for the purpose. The skins to be washed are hung together by twine drawn through holes in the foot pieces. However, since fresh twine would be required for each operation it has been endeavored to substitute another material for it, quite thin, well-tinned iron wire, bent to a hook of the form of an S, being found the most suitable for the purpose. It is absolutely necessary that these

FIG. 144.



hooks should be thoroughly tinned, since if the skin comes in contact with the iron itself, that portion would, in the subsequent dyeing, turn out spotted. Hence the hooks must be closely inspected, and any one which shows the bright iron through the tin coating immediately removed.

The apparatus consists of two vats (K and K_1). Into one of these vats the skins are brought as follows: The first skin is laid, flesh side down, and upon it, connected with it by hooks,

is placed the second skin, grain side down; upon this is laid the third skin, flesh side down, and upon the latter the fourth skin, grain side down, and so on. Above the vat (K) are fixed a few guide rolls and alongside of it are standards carrying two rolls (B and B_1). These rolls may be revolved in every direction, and their peripheries are furnished with bristles so that they actually form cylindrical brushes. In order to press the two rolls with a certain force against each other, a block of wood (H) is placed over each end of the axle of the upper roll. The blocks of wood are connected by a cross piece which carries a wooden box filled to a suitable depth with sand, whereby a moderate pressure is exerted. Alongside the standards carrying the brush rolls (B and B_1) are similar standards in which rest two wooden cylinders (C and C_1) of equal size, the surfaces of which are covered with vulcanized rubber. These rolls can be pressed together by means of a screw. To one of the rolls is fixed a crank as well as a pulley, the latter being connected by means of a belt with a pulley on B, so that both rolls must move simultaneously. The vat (K_1) is also provided with guide rolls arranged in the same manner as those on K.

When the skins have in the above described manner been placed in the vat, sufficient water to cover them is admitted, and they are then allowed to stand quietly for one hour. To avoid the formation of air-bubbles between the separate skins it is recommended to admit the water through a rubber hose while arranging the skins in the vat, and to regulate the flow of water so that the skins placed last are covered about one-half inch deep with water. If the skins have been properly brought into the vat they will be uniformly moistened in about one hour, and the mechanical manipulation may be proceeded with as follows: Lift the uppermost skin from the vat, push it between the brush-rolls (B and B_1) and set the crank on the roll (C) in motion. The skin as it emerges from between B and B_1 is pushed with the hand between the rolls (C and C_1). By the brush-rolls the entire surface of the wet skins is uniformly

brushed, and adhering particles of nourishing paste and of alum are removed. Where plenty of water can be had it may be recommended to arrange pipes perforated with small holes below the lower, and above the upper roll, and squirt water through them upon the skins. While such arrangement is not absolutely necessary, it facilitates the work.

As will be seen from the arrangement of the apparatus, the skins which have been manipulated between B and B_1 must pass between C and C_1, and are there subjected to a uniform and quite strong pressure, so that not only the water adhering to the surface, but also a portion of the water absorbed by them is withdrawn.

The skins having thus been quite vigorously expressed now reach the vat (K_1). The progress of the work should, however, be so regulated that the workman who has charge of the vat (K_1) has sufficient time to arrange the skins in it in the same manner as they were originally arranged in K, water being admitted at the same time.

In placing the skins in the vat (K_1), those which were on top in K come now on the bottom, which is of great advantage for the uniformity of the work, since the skins on the bottom are evidently subjected to the pressure of a higher volume of fluid than those on top, and are consequently soaked through in a much shorter time. When all the skins have in this manner been brought into the vat (K_1), they are allowed to remain in it for one hour. The belt is then detached from the two pulleys, and the contrivance carrying the brush-rolls (B and B_1) is so placed that it stands between the rubber-faced rolls (C and C_1) and the vat (K_1). The belt is then thrown upon the pulleys, and by revolving the rolls the skins are conveyed back to the vat (K).

If it is desired to manipulate many skins at one time, the vats (K and K_1) would have to be quite deep, which is, however, inconvenient for arranging the skins. It is therefore preferable to give the vessels the shape of a trough rather than that of a vat, so that four to six skins may be placed alongside one another.

Every time after the skins have been lifted from either of the vats, the water must, of course, be discharged. In dyeing establishments connected with a tannery the first wash water, which contains a certain quantity of alum in solution, may be used for dissolving the alum used in tawing.

One of the most important questions which arises is, how long must washing be continued? To answer this question properly it is necessary to enter somewhat into the consideration of the condition of leather.

According to the opinion prevailing at present regarding the nature of the tanning process, tanning is effected by the tanning agent—in this case alum—enveloping the fibers of which the skin-tissue consists and preventing the leather from becoming hard in drying, the nourishing paste co-operating thereby in the same manner. Hence the alum is deposited upon the fibers of the skin simply by surface-attraction, but if tawed leather be brought in contact with water the dissolving power of the latter overcomes the surface-attraction, and alum is removed from the surface of the fibers. Hence if a piece of tawed leather is allowed for some time to remain in water which is frequently changed, it can be completely freed from tanning material; i. e., reconverted into raw skin. By drying, such leather shrivels up to a hard, tough mass similar to raw skin, and if kept constantly moist, becomes finally putrid.

Of course, washing will never be carried to such an extent as to free the leather completely from tanning material. It must, however, be taken into consideration, that if washing be continued even somewhat too long, the surface may be partially divested of tanning material; and this has the double disadvantage that, in order to obtain leather of a proper degree of softness, an exceedingly large quantity of yolk of egg has later on to be used as nourishment, whereby the expense of production is unnecessarily increased, and besides a special alum-mordant has to be applied previous to actual dyeing, as otherwise there would not be sufficient alum upon the surface of the leather to fix the coloring matter. The latter difficulty is of

less importance in dyeing with aniline colors, they being substantive upon animal fibers; *i. e.*, they combine with them without previous mordanting, though they also adhere better when alum-mordant is present. Besides, in dyeing very delicate colors, for instance, straw-yellow or pearl-gray, the dyeing liquor has to be used in a very dilute state, and the small quantity of coloring matter is partially fixed by the alum still present in the leather and partially by the toning fluid used after the application of the dye. Hence, leather intended for very light colors may be washed somewhat longer than leather to be dyed dark, though regarding the latter a factor to be immediately discussed has to be taken into consideration; namely, if leather is to be dyed by the dipping process; *i. e.*, by dipping it in the dyeing liquor, it will, of course, be dyed upon both sides. This, however, is not desirable, since leather to be used for gloves, especially if dyed somewhat darker colors, would stain the skin and hence would not be available for that purpose. Hence, leather to be dyed by dipping should be washed to such an extent that the lower side fixes but a very small quantity of coloring matter, not sufficient to stain the hand, even if the upper side is dyed very dark.

From the explanations given above, the following rules in reference to washing leather may be deduced:

1. Leather to be dyed by the application of aniline colors should only be washed sufficiently to free the side to be dyed from mechanically adhering particles of nourishing paste and small crystals of alum.

2. Leather to be dyed by dipping should be washed until the lower side contains but very little alum, so that it will take only a small amount of coloring matter.

3. Leather to be dyed very delicate colors, either by dipping or brushing, may be washed longer.

4. The longer the leather has been washed, the more nourishing paste must be given in order to render it again sufficiently pliant.

It is scarcely necessary to give a fixed time required for

washing, since this depends largely on the nature of the skins to be washed and on the temperature of the wash water. The denser the leather is and the colder the water used, the longer the washing will have to be continued, since under these conditions it takes more time to moisten the fibers to a certain depth and to dissolve a corresponding quantity of alum. Hence for washing denser and stouter leather it is best to use somewhat warmer water, to shorten the time required for the operation. On the other hand, for thin, spongy skins water of the ordinary temperature should be used and great care observed in the operation. As previously stated the time required for washing cannot be given, it depending entirely on practical experience.

The dyer must ascertain by tests, which he makes with the skins, how long washing may suitably be continued. Such experiments are worth far more than working according to a fixed time, which can be correct only in a certain case.

QUALITY OF THE WATER.

A few remarks may here be made regarding the quality of the water to be used in washing and dyeing leather. The water must of course be perfectly clear. If after standing for some hours in a large bottle it deposits only a trace of solid substance, it is unfit for our purposes and has to be subjected to filtration, which will be referred to later on.

The chemical constitution of the water is also of considerable importance to the dyer. Many well waters, as is well known, are very hard, *i. e.*, they contain large quantities of calcium carbonate in solution, which causes the separation of aluminium hydrate from the alum; and in case somewhat more alum be present on one portion of the leather than on another, more aluminium hydrate will remain behind, whereby that portion becomes darker, and the leather, consequently, spotted.

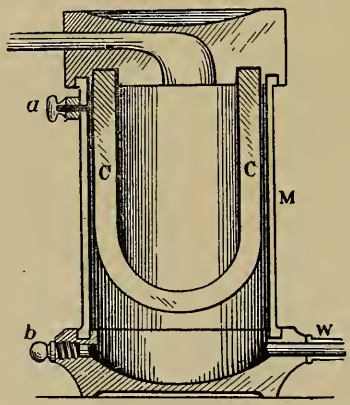
Such water can scarcely be used in washing and dyeing, but where no other can be had, it should be boiled before use, or what is more suitable for the large quantities required, compounded with soda solution. The soda renders the calcium

carbonate insoluble and the water becomes turbid in consequence. To avoid an excess of soda it is best to determine once for all the quantity required to separate all the calcium carbonate from say fifty gallons of water, and to use a proportional quantity. Bring the water into a large vat, stir in the soda solution, allow to settle and then draw off the clear water.

Borax should be used in preference to soda for softening the water, as it is one of the gentlest of the alkalies and is at the same time a fine mordant. One-half pound of borax is generally used to one hundred gallons of water. The borax is dissolved in boiling water and added under vigorous stirring. If the water is very hard a little more borax will be required.

For filtering turbid water Forster's sandstone filter shown in Fig. 145, is very suitable. It consists of a hollow sandstone

FIG. 145.

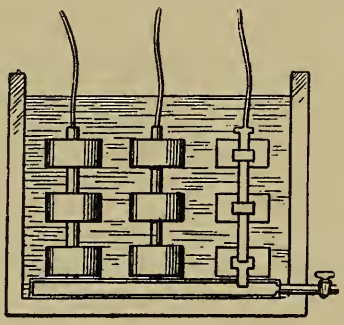


cylinder (*C*) having a clear diameter of 4 inches and a length of 8 inches. The cylinder is cemented in a cast iron lid, the latter sitting upon a sheet iron jacket inserted below in an iron foot. The water to be filtered passes under a certain pressure from the lower portion of the apparatus, at *W*, into the jacket (*M*), permeates through the pores of the sandstone cylinder (*C*) and runs off through the lid on top. When the pores of the cylinder are clogged up by solid substances to such an ex-

tent that filtration proceeds slowly, the cylinder is replaced by a new one, and cleansed by turning or grinding the surface.

If the water contains a considerable quantity of organic substances, the production of certain delicate colors with it is next to impossible, and in order to render it fit for use it has to be filtered through so-called plastic coal. The latter consists of animal charcoal dust or meal which is made into a paste with glue water. This paste is given definite shapes by moulding and the cementing agent destroyed by heating. The plastic coal generally has the form of a low hollow cylinder, and a number of such cylinders, for instance nine, sixteen, etc., are combined to a filtering battery, as shown in Fig. 146.

FIG. 146.



Each cylinder is about 8 inches in diameter and 4 inches high. The cylinders are connected with each other by short pieces of iron pipe. The lowest cylinder, with its pipe, is screwed to the false bottom of the vat and is connected with the uppermost by means of a rubber hose, which projects above the level of the water. With a filter of this construction, not only turbid water can be filtered clear, but it is also freed from organic substances in solution, the animal charcoal possessing the property of absorbing and retaining such substances.

NOURISHING.

No matter how much care may have been exercised in wash-

ing, the leather will always be somewhat hard if its original pliancy is not restored by the so-called nourishment.

For the nourishment of fine glacé leather, yolk of eggs is, as a rule, used, the effect of the fat, called egg-oil, contained in it, being such as to keep the leather pliable after drying. Chemically, yolk of egg consists of vitellin, a peculiar body belonging to the group of albumens, further fat and fat-like bodies (cholesterin, lecithine) and a special yellow coloring matter—lulein—and potassium salts. For our purposes, however, the effective body of the yolk of egg is the fat, which is in a state of emulsion, *i. e.*, in the form of very small drops suspended in the fluid. Since alkalies also possess the property of converting fat into an emulsion, it is recommended to use, besides yolk of egg, very small quantities of soda, but not more than about 8 grains for each yolk.

The quantity of yolk of egg to be used for a dozen skins depends on the size of the latter, and whether they have been washed more or less. It can only be said that from 3 to 12 yolks will have to be used for a dozen skins.

Besides oil of egg, the use of glycerin has been found to give excellent results, the leather acquiring great pliancy, since glycerin possesses the property of not drying up.

The operation of nourishing is effected in a vat capable of holding about ten dozen skins. Fill the vat about half full of water and stir in the yolk of egg so that a uniform milky fluid is formed. This is best effected by beating up the yolks of egg in a special vessel with water, adding about three drachms of glycerin for each yolk of egg used and mixing the whole with the water in the vat. The washed skins being well squeezed are best suspended to cross-pieces by pairs so that the sides not to be dyed touch each other, it being of chief importance that the side to be dyed be provided with nourishment. The skins are allowed to remain in the vat twelve to fourteen hours and, as a rule, they will have absorbed all the nourishment. Should, however, any of the latter remain after lifting the skins from the vat, it is used in the preparation of a fresh supply.

PRESERVATION OF YOLK OF EGG.

The price of yolk of egg being subject to great fluctuations, it being, for instance, much lower in the spring than in the fall, a mode of preserving it for any length of time may here be given. Prepare for this purpose a concentrated solution of salicylic acid in water by adding 2¼ drachms of salicylic acid to one quart of water in an enameled pot, then heat to boiling with constant stirring, and allow to cool. Salicylic acid requires about 300 parts of water for solution, and in cooling a portion of the acid is again separated and used in preparing fresh solution.

The eggs, the yolks of which are to be preserved, are opened and the yolks and whites carefully separated. The whites may in a fresh state be directly sold to cloth-printers, or they may by drying upon zinc sheets at 136° F. be converted into a solid mass, which may be kept for a long time. The yolks are brought into a vessel and intimately mixed with salicylic acid solution, one quart of the latter being used for three quarts of the former; thorough stirring and mixing being absolutely necessary for proper preservation. The resulting milky fluid is stored in a cool place in large glass bottles, which are closed with parchment papers soaked in the salicylic acid solution.

Yolks thus preserved with salicylic acid may be kept for months without suffering alteration. In dyeing, the acid exerts no influence whatever, except with the use of iron salts it would produce a red color.

Lanolin or wool-fat is particularly well adapted for leather nourishment, it imparting to the leather great pliancy. Lanolin possesses the characteristic property of mixing with an equal quantity by weight of water without losing its fatty nature. The "degras" used so largely in the currying of grain and split leathers is really lanolin—made from wool fat.

DYEING TAWED LEATHER (GLACÉ LEATHER).

The leather may be dyed either by the so-called dipping process or upon the board. In the dipping process the leather is immersed in the dyeing liquor, and, according to the old method, treated by treading with the naked feet until it has almost entirely absorbed the coloring matter. In modern times this crude method has been replaced by suitable apparatus.

In dyeing upon the board, only one side of the leather is actually dyed, the lower side, when the work is properly done, remaining almost entirely white. The operation is executed by applying the dyeing liquor to the leather spread on a level surface, and immediately bringing the leather into the dyeing chamber. In modern times the dipping process has been almost entirely replaced by dyeing on the board, since the aniline colors which are now almost universally used are substantive colors, and the leather would be dyed equally strong on both sides if the dipping process were used. The latter method is, however, still employed for leather to be dyed pale tones with the use of dyeing liquors.

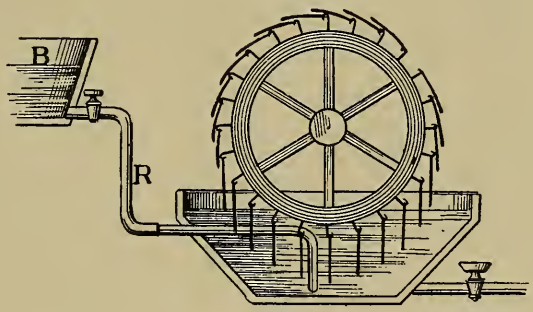
DIPPING PROCESS.

The older method of executing this process is as follows: The lukewarm dyeing liquor is brought into a vat and a number of skins, with the side to be dyed up, are introduced. A workman then enters the vat and by moving to and fro with his naked feet, endeavors to keep the skins as well as the dyeing liquor in constant motion. In the commencement of the operation the dyeing liquor becomes rapidly lighter, the coloring matter being quickly fixed by the leather. When the dyeing liquor is exhausted to such an extent as to be plainly visible, a certain quantity of fresh dyeing liquor is poured into the vat and treading continued until the pale appearance of the dyeing liquor indicates that the coloring matter has been fixed. Fresh dyeing liquor is then again introduced and the treading and adding of fresh dyeing liquor continues until the desired tone of color is obtained.

It will be readily understood that before each addition of fresh dyeing liquor one of the skins has to be taken from the vat and its color compared with the sample, as otherwise the tone of color might become too dark. It is therefore recommended to make an accurate note of the quantity of dyeing liquor required to dye a definite number of skins a certain shade of color, according to a sample book kept in the establishment. The data thus obtained are then strictly adhered to with slight modifications depending on the size of the skins to be dyed.

It seems to be suitable to use a simple dipping apparatus with the assistance of which one workman can manipulate without great exertion a large number of skins at one time. Such a dipping apparatus is shown in Fig. 147.

Fig. 147.



In a vat of the form shown in the illustration revolves a wooden wheel. This wheel is of sufficient width that a skin of a certain size can be fastened by the forefeet to two nails projecting from the surface of the wheel. For working on a larger scale the wheel is given the form of a drum, and sufficient width to suspend three or four skins alongside each other. If, for instance, the wheel is 6½ feet in diameter its circumference is nearly 20 feet, and to such a wheel, which is only wide enough for one skin, about sixty skins can be suspended; to a wheel with two widths 120 skins, and so on. The nails or

hooks to which the skins are suspended consist of tinned iron, and are bent so that the skins secured to them cannot drop off when the wheel revolves. These nails or hooks are placed at a distance of 3¾ inches from each other. The skins are suspended to the nails with the sides to be dyed in front.

The reservoir (*B*) is placed at a higher level, and contains the dyeing liquor. The pipe (*R*) issuing from the bottom of the reservoir is divided into two branches which run along the side of the vat to the centre and then branch off at a right angle. The portion bent downward is provided with narrow perforations. For discharging the fluid, the lower part of the vat is provided with a pipe furnished with a stop-cock.

The manner of operating this apparatus is very simple. The vat is filled with sufficient water so that the skins are moistened on revolving the wheel. In order to moisten every skin the wheel is allowed to revolve once and the stop-cock on the reservoir (*B*) is then opened to admit the dyeing liquor. The wheel is now kept constantly revolving. One skin after the other dips into the dye bath and after absorbing a certain quantity of the coloring matter is lifted from the bath, thus assuring uniform treatment of each skin. When dyeing is almost completed, the pipe admitting the dyeing liquor is closed either partly or entirely, and after revolving the wheel a few times more, the bath is discharged from the vat. The dyed skins are taken one after the other from the wheel and brought into the drying chamber.

The use of this apparatus offers the advantage that not only a considerable number of skins can be treated at one time, but also that the progress of the dyeing operation can at every moment be inspected, since a certain number of skins are constantly lifted from the bath.

When the skins have been taken from the dyeing liquor they are generally brought into a bath of yolk of egg, then pressed quite vigorously by passing through between two very smooth rolls—the so-called glazing rolls—and brought into the drying chamber.

DYEING UPON THE BOARD.

For dyeing upon the board the following utensils are required: A dyeing table, reservoirs for the mordants, dye-stuffs and toning fluids and brushes. These utensils should be so arranged that the workman can work without interruption, and the following arrangement may be recommended as very suitable:

The dyeing table or board should be perfectly level, and the plate consist of a material which does not absorb moisture, nor exert a chemical action upon the leather. The most suitable material for this purpose is zinc, since a sheet of this material can be readily secured to a thick wooden plate by bending it over the edges of the narrow ends of the latter. The use of nails should be avoided. The plate of the table should be fixed so as to be about three-fourths inch lower to the right than to the left, and on the right-hand narrow side, underneath the sheet, a small gutter is provided beneath which a tub is placed.

The fluids required in dyeing should be placed in the order used by the workman; the vessel containing the mordant to the left, the vessel with the dyeing liquor in the center, and that with the toning liquor to the right. Above the table hangs a rubber hose of sufficient size to throw out a jet of water the thickness of the thumb, when the cock with which it is fitted is opened. Each vessel is provided with a brush of soft, quite long bristles and furnished with a handle. Each brush should be used only for a certain fluid, and when the work is finished be immediately cleansed by thorough washing. In place of brushes many dyers use large bath-sponges tied to handles. For dyeing it is of course indifferent whether the work is done with brushes or sponges, the principal thing being the uniform application of the coloring matter.

The operation of dyeing is commenced by spreading the skin to be dyed perfectly smooth on the table and removing every wrinkle by gentle rubbing with a rounded off wooden

tool. The mordant is then applied, next the coloring matter, and finally the toning fluid. With the use of aniline colors it is only necessary to apply the coloring matter.

To avoid the formation of stains the workman should take just sufficient fluid in the brush completely to brush over one skin, and he should endeavor to apply the fluid uniformly to all portions of the skin. Whether he does this by carrying the brush in a spiral line or in a zigzag over the skin is entirely optional, the principal thing being that he works uniformly.

With the use of dye-stuffs obtained from decoctions of vegetable substances a mordant consisting of a dilute solution of an alkaline carbonate is generally first applied. The action of this mordant is as follows: By the alkali, alumina in the form of a precipitate is separated from the alum contained in the leather, and this freshly precipitated alumina combines very rapidly with the coloring matter, so that the latter is more completely and more quickly fixed. If sufficient alkali is present it acts also upon the salts used in toning by separating the respective metallic oxide, which combines immediately with the coloring matter.

Very dilute solutions of potash or soda are now used, 5 parts by weight of potash or soda in 100 parts of water being sufficient.

The skin having been uniformly moistened either with the alkaline mordant alone, or first with a tin salt mordant and then with the alkaline mordant, the dyeing liquor is immediately applied, the application being repeated until the desired shade of color is obtained, when the work is finished by applying the toning fluid.

When working with aniline colors it is only necessary uniformly to apply the solution of the coloring matter to the skin and to repeat the operation until the desired shade is produced.

The dyeing operation being finished, the workman by opening the cock on the rubber hose allows water to flow over the skin, turns it around, and after rinsing the back removes the

excess of water by vigorously rubbing the back of the skin with a tool provided for the purpose. He then spreads the skin, dyed side up, on a table standing alongside the dyeing table. The skin dyed next is laid, dyed side down, upon the first, the third dyed side up, the fourth dyed side down, and so on.

The workman having dyed a skin rinses the plate with water to remove any remaining coloring matter which might discolor the back of the next skin, and then proceeds with the operation.

DYES AND TONING FLUIDS.

The color mixtures which are particularly employed for tawed leather have been previously referred to, and but little remains to be added. It is considered unnecessary to give definite receipts, since they would produce only one tone of the respective color, while the modifications of one and the same color are very numerous. It is, therefore, decidedly preferable to have given to our readers the methods by which a permanent sample card of colors and their modifications can be obtained, namely, by systematic dilution of dyeing liquors and subsequent mixing. Such colors and modifications once determined and entered in the sample book can always be reproduced.

Regarding the aniline colors, it may be remarked that by reason of their great dyeing power they should be used only in the form of very dilute solutions. Thirty to forty-five grains of aniline color dissolved in a fluid are sufficient for the production of beautiful colors, and the dyer by applying twice or three times such solutions of moderate concentration can readily obtain any shade desired.

Indigo carmine being next to the aniline colors as regards dyeing power must also be used in dilute solution. To avoid defects the solutions of aniline colors and of indigo carmine should be filtered before use. If, for instance, the dyeing liquor holds in suspension a scarcely perceptible solid particle of aniline color, the consequence would be that in applying the

liquor with the brush, this particle would produce a very dark-colored streak, and the coloring of the leather would thereby become defective.

As dyes, in the actual sense of the word, it is best for colors of a pure tone to use aniline colors, namely, for red and its modifications, fuchsin; for yellow, picric acid; for green, iodine green; for blue, indigo carmine or aniline blue; for violet, methyl-violet. These colors may be modified by mixing with other colors, yellow, for instance, being changed to orange by adding red; red into purple by adding blue, and so on.

For dying glacé leather intended for fancy goods, the use of aniline colors may be recommended as most suitable; but for dyeing glove leather blended colors, such as brown, gray and olive green, which are at present very much in demand, liquors of dye stuffs are to be preferred.

While formerly the dyer had to use a larger number of dye-stuffs in order to obtain a certain shade, at present decoctions of fustet, Brazil wood, logwood and alder bark suffice for most purposes. The modifications of the colors are effected besides with the use of toning fluids by small additions of aniline colors, such as picric acid, fuchsin or water-soluble blue, to the mixed decoctions.

DIRECTIONS FOR THE PRODUCTION OF BLENDED COLORS UPON GLACÈ LEATHER.

A number of receipts are here given according to which the most important blended colors, especially those used for glazed glove leather, may be prepared.

The receipts marked II. give colors which may be designated the medium shades of the respective colors, while No. I. yield very light and No. III. very dark shades. The figures refer to units of fluid of the concentrated dye liquors:

Light ochre yellow and maize yellow, decoction of:

	I.	II.	III.
Fustet	25	50	30
Brazil wood	30	12½	1½
Logwood	1½	12½	31

Dark gold ochre to umber, decoction of:

	I.	II.	III.
Fustet	6	5	45
Brazil wood	1½	11	20
Logwood	5	11	14

Wood brown to mahogany color, decoction of:

	I.	II.	III.
Fustet	35	13	24
Brazil wood	2	16	4½
Logwood	6	5½	53

Reddish brown to Venetian red, decoction of:

	I.	II.	III.
Fustet	7½	25	50
Brazil wood	5	17½	30
Logwood	22	3	3½

Brownish red (Pompeian red), decoction of:

	I.	II.	III.
Fustet	52	6	50
Brazil wood	5	26	3
Logwood	20	11	1½

Pure Havana brown, decoction of:

	I.	II.	III.
Fustet	50	50	50
Brazil wood	27½	10	7½
Logwood	2½	7	1

Sienna brown, decoction of:

	I.	II.	III.
Fustet	50	32½	9
Brazil wood	9	8	32½
Logwood	7½	1	6

Dark bister brown, decoction of:

	I.	II.	III.
Fustet	50	30	50
Brazil wood	1	7½	15
Logwood	2	10	2½

Olive, decoction of:

	I.	II.	III.
Fustet	50	50	5
Brazil wood	5	10	50
Logwood	1	27½	10

Red brown to dark brown, decoction of:

	I.	II.	III.
Fustet	15	25	37½
Brazil wood	37½	25	12½
Logwood	4	17½	4

Green brown to dark brown, decoction of:

	I.	II.	III.
Fustet	37½	22½	3
Brazil wood	4	17½	30
Logwood	6	12½	15

Lac brown and dark brown, decoction of:

	I.	II.	III.
Fustet	52½	37½	30
Brazil wood	3	7½	27½
Logwood	6	3½	5

Sepia brown, decoction of:

	I.	II.	III.
Fustet	42½	40	2½
Brazil wood	27½	3	12½
Logwood	18	16	40

Iron violet, decoction of:

	I.	II.	III.
Fustet	16	27	50
Brazil wood	36	14	1
Logwood	10	6	6

Gray blue (dark pigeon gray), decoction of:

	I.	II.	III.
Fustet	25	30	50
Brazil wood	5	9	15
Logwood	25	32½	4

Slate gray, decoction of:

	I.	II.	III.
Fustet	15	15	35
Brazil wood	10	15	50
Elder bark	50	32½	50

Iron or steel gray, decoction of:

	I.	II.	III.
Fustet	1	11	30
Brazil wood	10	6	1
Logwood	9	14	27½
Elder bark	27½	37½	50

Light ash gray, decoction of:

	I.	II.	III.
Fustet	27½	50	30
Brazil wood	8	6	30
Logwood	30	11	10
Elder bark	—	1½	2

It only remains to give here the toning fluids to be used for the different broken colors, and to mention that the numbers of the separate fluids are so placed that in this case the higher number also produces a deeper tone.

Mixtures of various quantities of decoctions of fustet, Brazil wood and logwood are used for:

Light ochre yellow, maize yellow to dark gold ochre yellow: Toning with alum for the light shades, and with sulphate of zinc for the darker shades.

Light wood brown to sad mahogany color: Toning with sulphate of zinc.

Havana brown through red to an indefinite olive color: For the lighter shades sulphate of copper 1 and 2, for the darker shades 3 and 4.

Lac brown and dark brown, with sulphate of copper 1 and 2.

For slate gray in all its modifications: Copperas 1 to 4.

For iron violet in all its modifications: Sulphate of copper 1 to 4.

For reddish violet: Sulphate of zinc.

Mixtures of various quantities of fustet, Brazil wood and logwood besides elder bark are used for:

Stone gray with copperas 1 and 2.

Olive green with copperas 1, 2 and 3.

Gray green with copperas 1 and 2.

Steel gray with copperas 2.

Remarks: A quite satisfactory black may also be produced by a mixture of decoctions of fustet, Brazil wood and logwood, in which the latter should especially preponderate, and with the use of a toning fluid containing potassium chromate in solution. However, the process does not suffice for the production of a pure lustrous black, and dyeing leather black forms a special branch of the glacé leather dyeing industry.

In conclusion it may be added that the above mentioned instructions regarding shades of color and toning fluids refer to dyeing upon the board. The lighter modifications of these colors, especially ochre yellow and pale green, may also be produced by dipping, but in this case the dye liquor should be somewhat darker, as the color is not toned.

MIXED COLORS.

This term may be applied to colors produced from a mineral color—Berlin and chrome yellow—and an organic dyestuff. While these colors were formerly quite frequently used for the production of neat effects, they have at present been almost entirely abandoned, the aniline colors being by far more convenient for obtaining the same shades.

Dyeing with mineral colors is effected by giving a mordant consisting of a salt, applying upon this the solution of another salt, whereby either pure blue or pure yellow is obtained. Now by laying upon the blue pure yellow, green is obtained; by using pure red, violet is formed; or by laying pure red upon chrome yellow, orange—in one word, every shade of color may in this manner be obtained, the production of agreeable modifications being in this case largely dependent on the skill of the workman in harmonizing the colors.

Thus, for instance, by applying picric acid solution to leather dyed with Berlin blue, all shades from pale grass green to dark malachite green may be produced; light olive green upon leather dyed with Berlin blue is obtained with quercitron and archil.

In the reverse manner, by applying water-soluble blue to leather dyed with chrome yellow, various shades of green may be produced, while by the use of fuchsin orange is obtained, by the use of elder bark, sallow shades with a grayish tinge, and so on.

For the production of all these colors the leather has to be handled three times, namely, mordanting, dyeing and applying the organic coloring matter, while in working with aniline colors the desired shade is obtained by one manipulation.

DYEING LEATHER BLACK.

Dyeing leather black is by many considered a special art, but actually it is not more difficult than any other color, the only thing necessary being the proper choice of the dyestuff.

If a fluid containing tannin in solution, for instance, a decoction of tan-bark, gall-nuts, etc., be compounded with an iron salt, it is immediately colored deep black, and this process was formerly exclusively employed in the manufacture of ink, the very delicate precipitate formed in the fluid being held in suspension by the addition of gum solution.

By diluting the solutions of the tannin and of the iron salt, and pouring them together, it will be observed that the fluid is not black, but rather green or blue, and the coloration depends on the nature of the tannin used as well as on that of the iron salt (ferrous or ferric oxide). The color appears black to the eye only when the fluids are in a more concentrated state, but always with an admixture of green or blue, so that actually we have only a very dark green or blue, but not a black. By applying a fluid containing tannin to leather previously mordanted with iron salt (copperas or acetate of iron), a precipitate is formed, and the leather is colored blue-black or green-black.

By adding to a decoction of logwood a very small quantity of potassium chromate solution, the fluid is immediately colored deep black-blue without, however, a precipitate being formed. The chemical process of this phenomenon is not yet thoroughly understood, but it is supposed that a soluble chrome combination of the coloring matter is formed.

Now this behavior of bodies containing tannin towards iron salts or that of logwood decoction towards potassium chromate may be utilized for dyeing leather black, but very frequently mixed fluids are used.

DYEING WITH TANNIN AND IRON SALTS.

This mode of dyeing is seldom used for finer qualities of leather, but frequently for shoe leather. For dyeing tanned leather it is only necessary to apply the solution to the leather, the tannin contained in the latter being sufficient to produce coloration. However, as a rule, the leather is first treated with a decoction of tanning material, generally of gall-nuts or sumac, and then dyed with the iron salt. It is recommended to ascertain, previously to dyeing, the proper constitution of the solution by a small experiment, because with the use of too small a quantity of tannin the resulting color will not be dark enough, but show a sallow tone. It is also of importance not to use more of the iron salt than absolutely necessary, since experience has shown that an excess renders the leather brittle.

DYEING WITH LOGWOOD AND POTASSIUM CHROMATE.

The solution of the logwood coloring matter may be prepared either by boiling rasped logwood with water, or by dissolving solid logwood extract in water. In working according to the first process it is best to prepare a completely saturated solution of the dye-stuff by boiling a large quantity of the wood for several hours and straining the solution. However, working with solid logwood extract is much more convenient, since by a few experiments it can be readily ascertained how much water has to be taken for a certain quantity of extract in order to obtain a dyeing liquor of the proper concentration.

The leather is treated with the solution of the dye-stuff and then brushed over with the solution of potassium chromate. For this purpose the toning fluid No. 1 may be used, but it must be suitably diluted with water.

By using the solution of logwood extract in a too concentrated state it will be observed that the color acquires a peculiar metallic luster which should be avoided in dyeing black, and this can be done by simply diluting the solution with water.

With proper concentration of both fluids a beautiful black with a bluish tinge is immediately obtained. This bluish tinge may be heightened by adding to the logwood decoction a small quantity of indigo carmine, or by slightly dyeing the leather with aniline blue before applying the logwood solution.

DYEING WITH TANNIN AND LOGWOOD.

The majority of leather dyers prefer mixtures of the colors, which can be produced by tannin and logwood, and there is good reason for this preference, because the tannin color is generally somewhat greenish and the logwood color bluish, while both together, with a little fustic decoction, give black.

A receipt, according to which, for instance, a very beautiful black upon leather may be obtained, is as follows: Boil tan 100 parts, logwood 25, fustic 12, water 250. Apply the resulting liquor to the leather, and then solution of copperas, to which a small quantity of nitric acid has been added, or solution of acetate of iron. A still better result is obtained by adding to the iron solution a small quantity of potassium chromate.

The methods of dyeing black described above may be used for tanned, chamois and tawed leather. In dyeing the latter, especially thin skins, care must be taken to prevent the dye from penetrating the leather, which is best effected by applying to the side to be colored, prior to the actual dyeing, solution of soda or potash, and by using the dyeing liquor no more diluted than is absolutely necessary.

DEEP BLACK NIGROSIN COLOR.

Dissolve 40 parts borax in 800 parts water by heating, bring gradually into the solution 150 parts pulverized brown shellac and boil until all the shellac is dissolved, from time to time replacing the water lost by evaporation. Now triturate 40 parts nigrosin (aniline black) with a portion of the solution to a thick milky fluid which is finally intimately mixed with the remainder of the borax-shellac solution. This preparation, when applied with a brush, gives a lustrous, deep black color immediately after drying.

BLUE BLACK NIGROSIN COLOR.

I. Dissolve in 400 parts water, 30 parts borax and 3 parts caustic soda, introduce 130 parts brown shellac and boil until the latter is dissolved.

II. Dissolve in 300 parts water, 50 parts logwood extract, 20 parts aniline deep black, and add 10 parts glycerin. According to whether the color is to show a more or less blue tinge add 5 to 10 parts methyl-blue.

III. Compound the mixture of solutions I. and II. with 50 parts of a 20 per cent. acetate of iron solution and 90 parts water.

Actual high lustre is imparted to leather dyed black only by the so-called polishing or glossing, and this operation has to be distinguished from glazing, to which tawed leather of other colors is subjected.

GLAZING AND GLOSSING OF LEATHER.

Glazing.—This operation is executed in various ways, but best with the use of a decoction of flaxseed mixed with solution of white soap. The flaxseed contains a mucous substance which dissolves in water by long boiling and in drying forms a lustrous mass which does not possess the hard glossy luster of gum.

The glazing fluid is prepared as follows: Wash the flaxseed in cold water to remove adhering dust, and then boil it with

four or five times the quantity of water for one hour. Filter the cold fluid through a closely woven cloth into an enameled vessel for the purpose of boiling with the soap. Use pure white grain soap free from any disagreeable odor. Convert the soap into thin shavings, introduce the shavings in small portions at a time into the boiling fluid and promote solution by vigorous stirring. From time to time take a sample from the vessel and cool it rapidly. If it forms a slippery, slightly opalescent fluid, the solution contains enough soap and is then again strained through a cloth. Add to the cold fluid a few yolks of egg, and beat up the whole until a uniform mass is formed.

By adding to the boiling fluid some olive oil, at the utmost 5 per cent. of the quantity of soap used, a glazing fluid is obtained which imparts to the leather greater flexibility than is obtained with the above-mentioned fluid.

The glazing fluid is applied to the leather in a manner similar to the coloring matter, care being however taken to put it on in a very thin layer, since the thinner the layer the more beautiful the luster will be. It is best to use a large soft bath-sponge which after being dipped in the fluid and squeezed out, is passed with slight pressure over the leather. Immediately after drying the leather shows a beautiful luster, which may be still further heightened by passing the leather through between two rapidly revolving rolls covered with flannel.

Tawed leather, not dyed, is glazed in the same manner as described above, with the exception that the glazing fluid is applied twice, since undyed leather absorbs more of the fluid than dyed leather, and hence one application would not produce a high luster.

In place of the above described glazing a solution of solid white of egg, so called patent albumin, in water with an addition of about 5 per cent. of the weight of albumin used, of glycerin, may be employed. With proper concentration of this albumin solution, a glazing fluid is obtained which with one application and subsequent passing through between the flannel-covered rolls, imparts to the leather a high luster.

Glossing.—Glossing of ordinary leather is very frequently effected by brushing the leather over with a rind of bacon and rubbing with a cotton ball covered with linen until the desired luster is produced. For finer qualities of leather a glossing mass consisting of a fat-emulsion, which also contains soap, may be advantageously used. Such glossing mass of excellent quality may be produced by boiling a good grade of white grain soap with five times the quantity of water until a perfectly clear soap paste is obtained, and adding to this soap solution, oil and a certain quantity of stearic acid. The effect of the alkali in the soap and the soda is that after continued stirring the oil is divided into very fine drops, and an emulsion is formed. By rubbing the leather with this mass it absorbs the oil, which renders it pliable, while an agreeable gloss is imparted by the soap. A glossing mass suitable for the most delicate colors may be prepared according to the following formula:

White grain soap	2 lbs.
Water	5 qts.
Soda	14 ozs.
Dissolved in water	21 ozs.
Olive oil	17 ozs.
Stearic acid	5 ozs.

Introduce the soap solution into the soda solution and then add the oil and the stearic acid. Heat to from 140° to 158° F., and stir until the whole forms a uniform, milky mass.

After applying the glossing mass draw the leather, colored side down, over a dull blade, and finally rub it with the above mentioned cotton ball. In place of the latter an apparatus may be used which consists of two wooden rolls, the lower one of which is covered with rubber and the upper one with cloth, which, however, should not be too rough. The leather, colored side up, is placed upon the lower roll and, while the upper roll revolves rapidly, allowed slowly to pass through. It must, of course, be held on one side, otherwise it would be carried

along by the rolls. By this treatment the leather acquires a beautiful lustre, and this operation in most dyeing establishments finishes the manipulation.

While formerly soap-like bodies or fat-emulsions (degras) were exclusively used for rendering the leather pliable and for glossing, in modern times these substances are frequently replaced by bodies obtained in the manufacture of petroleum, such as vaseline, or by products of the tar industry, such as paraffin and paraffin oil. Compared with fat-like substances they have the advantage of not containing free acids and not becoming rancid.

In a pure state vaseline is white or yellowish, of salve-like consistency, liquefies by slight heating and readily penetrates the leather, imparting to it permanently a high degree of pliancy. Paraffin is at the ordinary temperature a solid crystalline body of alabaster-like appearance, and melts on heating. There are varieties of paraffin with a melting point above 158° F., but while excellent for the manufacture of candles, they are not suitable for our purpose. However, from the hardest varieties down there are a large number of paraffins whose melting points are much lower, and which are soft like warmed wax. Such paraffins, as well as those liquid at the ordinary temperature—so-called paraffin oils—are especially suitable for making leather pliable, and for glossing purposes. They may be used either by themselves or melted together with carnauba wax, turpentine, etc.

GLAZING ROLLS.

Passing the leather through between glazing rolls is a very suitable operation, it acquiring thereby not only a high luster, but also uniform thickness. The apparatus consists of two smooth rolls forced together by a loaded lever which presses uniformly upon the bearings of the upper roll. The leather to be glazed is placed between two polished sheets of zinc, so that no wrinkles are visible, and then passed slowly through between the rolls.

DYEING RABBIT SKINS BLACK.

First the hair is deadened with a so-called "green bath," which is composed of 9 ozs. green vitriol, 1 oz. acetate of copper crystals, 2¼ ozs. copper ashes and 1 quart urine. The skins are spread upon the table, as usual, and the hair for 4 hours moistened with the mixture by means of a brush. The green looking skin is then dried and cleaned. For a very dark color the green bath is once or twice repeated. Then a dye is prepared by mixing 3¼ lbs. roasted and powdered nutgalls with the solution of 1¾ ozs. green vitriol in ¼ pint boiling water, to which, after cooling, 3 quarts water is added under stirring. The skins are for 4 hours moistened with the dye, dried, again treated with a mixture of 1 pint green bath and ⅔ quart urine, dried, again brushed with equal parts of the dye and warm water, kept moist for 4 hours, dried, and finally cleaned with bran, brushing and currying.

Or, prepare a bath containing 37½ grains potassium bichromate and 15½ grains cream of tartar per quart, and lay down in it the well-cleaned skins for 8 hours at 86° to 104° F. Then take up, rinse well, enter a bath containing per quart 46¼ grains Ursol (Actien Gesellschaft fuer Anilinfabrikation, Berlin) at 86° to 104° F., turn lively at first, then lay down for three hours, when take up the skins, add 100 ccm. hydrogen peroxide per quart, re-enter, lift after 10 hours, air for 1 hour, rinse well and dry. If not deep enough, add 15½ grains Ursol D. and 1 oz. hydrogen peroxide to the old bath, re-enter and proceed as before.

APPENDIX.

METHOD OF COLORING CHROME-TANNED LEATHER.

Wm. M. Norris, of Princeton, N. J., patented August 10, 1897, the following process or method of coloring leather. The letters patent are No. 588,000. Mr. Norris, in describing his improvement, says:

"My invention consists of certain improvements in methods of coloring leather, whereby I can with economy obtain more even shades of color than usual, and attain other advantages which are duly set forth hereinafter.

"My process is especially adapted to chrome-tanned stock, upon which heretofore it has been difficult to produce even and satisfactory shades of color, owing to the nature of the tanning materials employed. The oxide of chromium formed in the leather when this method of tanning is practiced, does not supply an effective base or mordant for any of the coal-tar colors, and if, as is likely to be the case, some of the sulphurous acid, which is largely employed as a reducing agent in the manufacture of chrome-tanned leather, remains in the latter in spite of the thorough washing to which it is subjected, such sulphurous acid acts as a bleaching agent, which injuriously affects the coloring materials used and tends to prevent the proper coloring of the leather.

"Heretofore in making colored leather from chrome-tanned stock the skins are, after being tanned and washed, put into a solution of some vegetable tanning matter, such as some bark or wood extract or gambier, and then placed in another bath containing some coal-tar color or anilin. I find in the working of this process that owing to the conditions referred to above an uneven, unsatisfactory color is often the result, and that the vegetable tanning agent employed causes deterioration in the quality of the leather. These difficulties are avoided by my improved process, which is practiced as follows:

"In a reel containing about six hundred and fifty gallons of water I dissolve three pounds of permanganate of potash, the temperature of the bath being about 98° Fahrenheit. Into this solution I place about

one thousand pounds of stock which has been thoroughly washed after being removed from the hyposulphite or reducing bath. At the end of half an hour the stock should be removed from this bath, washed to remove any of the permanganate which has not combined with it, 'struck out,' and finished in the usual way. This treatment alone produces a yellowish-brown color, which is now in demand, but if other colors or shades of color are desired, the stock, after being washed to remove the free permanganate, is placed in a solution of any suitable coal-tar, anilin, or other coloring matter, depending upon the color desired, and then finished in the usual way. Permanganate of potash destroys any sulphurous acid which may remain in the stock and is rapidly reduced by the skins themselves, the insoluble compound of manganese formed in the stock being of a yellowish-brown color and supplying an effective mordant for other coloring matters without altering or injuriously affecting the quality of the leather.

"In order to impart to the flesh side of the skin the bluish color which is now generally adopted when the grain side of the skin is black, the skin should be first treated by the permanganate solution referred to above, then washed, and then placed in a drum with a very dilute solution of some suitable anilin, such as methyl-violet. In this way a good penetration of color can be secured and a good foundation-color for the black formed on the grain side of the skin, there being no injury to the skins such as follows the use of large quantities of log-wood and soda, which are now employed in the endeavor to secure a penetration of color on chrome-tanned stock.

"Increased firmness and rigidity of the leather may be secured by subjecting the skins to a bath consisting of a dilute solution of ferro-cyanide of potassium (yellow prussiate of potash), say about five pounds of the ferrocyanide to six hundred and fifty gallons of water, preparatory to treatment with the bath of permanganate of potash, as described above.

"In working my process I have found that the best results are obtained by using the proportions specified, but I do not confine myself to these proportions, although in using such an article as permanganate of potash, which is a powerful oxidizing agent, dilute solutions only should be employed."

ART OF TAWING HIDES OR SKINS.

The specification for Wm. M. Norris' patent No. 588,874, dated Aug. 24, 1897, is as follows:

The invention relates particularly to that method of tawing leather now being largely practiced and known as "chrome" tanning, and the object of the invention is to attain greater economy and other advantages, hereinafter particularly pointed out, in the practice of said method.

The "beam-work" of my improved process is substantially the same as the beam-work in chrome tannage as at present ordinarily practiced, and the tanning is substantially the same, with the exception that in my improved process I provide for a continuous evolution of nascent hydrogen in the second or reducing bath. This nascent hydrogen operates to change the thiosulphuric acid or the sulphurous acid present or liberated in said bath into hyposulphurous acid, which is a more powerful reducing agent and possesses other advantages, hereinafter referred to.

By the term "hyposulphurous acid" as used in this description I mean not the compound which has been some time so called, and which is otherwise and more properly known as "thiosulphuric acid," but the compound expressed by the symbol H_2SO_7 or $H_2S_2O_4$, and known also as "hydrosulphurous acid."

I first tan or taw the hides or skins by subjecting them, as heretofore practiced, to bichromate of potash or analogous salt, such as bichromate of soda, dissolved in water, to which an acid, such as hydrochloric acid, is added, taking, say, for each one hundred pounds of raw hides or skins about five pounds of bichromate of potash or its equivalent and two and one-half pounds of hydrochloric acid of 21° Baumé or an equivalent amount of sulphuric acid, the amount of water in the bath being sufficient to properly cover the skins. The hides or skins having been left in this bath until thoroughly impregnated with the chromium compound are then removed, pressed or "struck out" to remove surplus liquor, when the stock is ready for the reducing bath.

So far my improved process does not depart from the process of chrome tanning as now ordinarily practiced, but in the present practice of chrome tanning, as known to me, the second or reducing bath consists, ordinarily, of hyposulphite of soda, by which I mean the compound $Na_2S_2O_3$, more correctly designated as "sodium thiosulphate," and hydrochloric acid in water. The thiosulphuric acid liberated by the action of the hydrochloric acid upon the hyposulphite of soda in this ordinary reducing bath is very unstable, and is resolved almost as rapidly as generated into sulphurous acid and sulphur, this action being so quick and energetic as to be easily observable. The active agent, therefore, in this bath is sulphurous acid, with which the hides or skins

become impregnated, while sulphur is thickly deposited in the fibres on the grain and flesh sides of the hides or skins. To free the latter from the sulphurous acid and sulphur requires a thorough washing, which usually takes considerable time and requires the use of a number of reels or other apparatus, which might be otherwise more advantageously utilized, consumes, furthermore, much water, and is sometimes injurious to the leather. To overcome these objections to the now commonly employed reducing bath, I add to said bath metallic zinc, whereby there is continuously liberated in the bath nascent hydrogen, which operates to convert sulphurous acid, when formed, into hyposulphurous acid, the reaction being expressed by the equation

$$2H_2SO_3+H_2=H_2S_2O_4+2H_2O,$$

or, as it is stated in other books on chemistry,

$$H_2SO_3+H_2=H_2SO_2+H_2O,$$

and, doubtless, it operates also to lessen or prevent the formation of sulphurous acid by converting the thiosulphuric acid produced by the action of the hydrochloric acid upon the hyposulphite of soda directly into hyposulphurous acid.

The method which I prefer for the development or liberation of the nascent hydrogen is the very simple and economical method of placing a number of pieces of metallic zinc in the vessel containing the bath, these pieces being, where a reel is employed, sufficiently large and heavy to remain at the bottom of the bath without being disturbed by the motions of the liquor caused by the paddles in the reel. The bath being acid, a continuous liberation of nascent hydrogen from the metallic zinc will take place, but I wish it understood that I do not confine myself to this particular method of evolving nascent hydrogen in the bath, as other modes may be employed.

I have found the following to be an efficient reducing bath made in accordance with my invention, although it will be understood that the proportions specified may be departed from without departing from the invention. For the treatment of, say, one thousand pounds of skins, a bath of 125 pounds of hyposulphite of soda and 50 pounds of muriatic acid in 650 gallons of water is prepared, and to this bath is added 60 pounds of metallic zinc. The zinc should be allowed to remain when the liquor is drawn off after the bath is exhausted and a new bath is prepared, and about 5 pounds of metallic zinc should be added about once a week.

Instead of having pieces of zinc at the bottom of the reel, the latter may be lined with sheet zinc, thus exposing a large surface to the action of the acid solution.

Some manufacturers for their reducing or second bath use instead of hyposulphite of soda and acid, a solution of what is commercially known as "bisulphite of soda," prepared for this purpose. This I understand to be an aqueous solution of sulphite of soda saturated with sulphurous acid gas, and the bath may be the same as before given, except that the acid is omitted and the hyposulphite of soda is replaced by an equal number of pounds of the bisulphite solution. In this case the zinc is used in substantially the same way as formerly described in connection with the reducing bath of hyposulphite of soda and muriatic acid. Although no sulphur is developed in such a solution, the liberation of nascent hydrogen in such a bath would convert the sulphurous acid into hyposulphurous acid, which would be an advantage, and much less bisulphite would be required. Hence, my invention is applicable to a bath of this character, and is so claimed.

Nascent hydrogen acting upon a solution of bisulphite of soda gives rise to the reactions which are expressed by these equations:

$$4NaHSO_3+H_2=H_2S_2O_4+2Na_2SO_3+2H_2O,$$

or

$$2NaHSO_3+H_2=H_2SO_2+Na_2SO_3+H_2O.$$

It is customary after skins are taken from the first or chrome bath and struck out to dip them each singly into a dilute solution of hyposulphite of soda, to which muriatic acid is added, this treatment being for the purpose of bringing the stock into the best condition for the reducing bath, and for effecting a slight surface reduction, which acts to prevent the washing out of the chromium compound from the stock when placed in the reducing bath.

A zinc-lined vessel may be advantageously used to contain the solution into which the stock is thus dipped, or pieces of zinc may be added to the solution, as the nascent hydrogen which will thus be developed will increase the efficacy of the solution, less hyposulphite of soda will be required, and less sulphur will be developed.

The results of my improvement are:

First. A comparatively small amount of sulphur is liberated and little or no sulphurous acid brought into contact with the skins or hides, so that when the latter are taken from the reducing bath very little wash-

ing is necessary to perfectly cleanse them and make them quite neutral and in good condition for the subsequent finishing operations, and in this way material economies of time, labor and apparatus are gained.

Second. Hyposulphurous acid being a much more powerful reducing agent than sulphurous acid, the quantity of hyposulphite of soda requisite for the reducing bath is by my improvement materially reduced. About one-half of the quantity of hyposulphite of soda heretofore considered necessary will in my improved process suffice—that is to say, where 20 per cent. of the weight of the skins of hyposulphite of soda and 5 per cent. of the weight of the skins of muriatic acid have been used heretofore, 10 per cent. of hyposulphite of soda and 5 per cent. of muriatic acid will be sufficient when my improved process is employed.

BORAX.

Tanners and curriers fully realize that soft water is a great aid in making good leather. Some of the most beautiful leather in the world comes from Denmark. In that country spring water is a great rarity, and the many small streams and lakes are fed mainly by rain water; the water is very soft, and particularly well adapted for the production from raw material treated with it of a pliable leather of most excellent feel.

The waters of the United States vary greatly in their hardness, and many a tanner has failed in business because there was a leak in his tannery which he could never find, search as he would, and this leak was constant in its working, never ceasing, eating his profits away, eating up his hides and skins, eating up his bark pile, eating up his dye stuffs, and in the end ruining him beyond repair. This leak worked in the day time, in the twilight, in the night, on Sundays and on all other holidays, constantly the same. This leak was hard water.

There is no necessity for any tanner, or currier, or leather dyer to work with hard water, as one of the best water softeners in the world is now within his reach at a low cost. We refer to borax, which can now be bought for about 5½c. per lb.; and 5 lbs. of borax will soften 1,000 gallons of water and render it fit for the soaks, the leaches, or the dye house. It is best to first dissolve it in boiling water and then add the water to be used under constant stirring.

Borax is also one of the best known agents for whitening or bleaching leather of all kinds. Every known variety of russet leather is bleached with borax and sulphuric acid. After this variety of leather is shaved, it is put into a pin-wheel with a solution of borax, 2 pounds

to 100 gallons of water, and washed thoroughly. While it is still in the wheel, it receives a bath of weak sulphuric acid to neutralize the alkali, and, at the same time, take out any iron stains that may be in the leather. The borax bath is drawn off before the sulphuric acid bath is applied. The borax bath works out the dirt and makes the leather appear much darker. The sulphuric acid bath changes the color of the leather to a much lighter shade than it was originally.

This is one of the secrets of the chrome process of tanning kid. Some manufacturers make their kid of a nice white color, and all of the other manufacturers are wondering how they do it. The above process of bleaching or whitening the leather with borax and sulphuric acid explains it. In kid some makers after the sulphuric acid bath is drawn off, give the leather a hot bath of Sicily sumac and alum, which imparts a still lighter shade, and at the same time softens it. The kid is then rinsed in clear water in a tank, and is immediately struck out to remove the water and surplus sumac. The leather is now ready to be dyed or colored. Then, again, the working of the dirt out of the hide or skin by the aid of borax before placing it in the tanning liquor, be the liquor vegetable or mineral, is a great help to rapid tannage, as it is well known that the cleaner a hide or skin is, when it is placed in the liquor, the quicker it can be tanned. Borax is one of the gentlest of the alkalies; but it is the mortal foe of dirt. It utterly destroys it, and that is the secret why all the laundries in the country use borax to soften the water in which they soak or wash the clothes to be laundered.

Borax is also one of the greatest preservatives known. All the larger packers of the country are using it to preserve their meats, and it is also being used as a preservative for hides and skins in the place of salt. It leaves no salt stains, and hides or skins preserved with borax are therefore worth more than those preserved with salt.

In the making of "sig" stains, blacks and pastes for leather, borax is the currier's friend; if the water is hard it is not good for these purposes, but a little borax softens the water and makes it fit for use. The same is true of the finishes. No other agent will cut the shellac used and soften the water so well as borax. It is also one of the best known agents in the preparation of blood and egg albumen, and is equally good in the preparation and preservation of egg yolk, so much used by makers of kid and glove leather.

Borax has been used in the leather industry for more than fifty years, each year extending its use, until now no tanner, currier or leather dyer

can afford to be without it. He must keep it on hand the same as he does his bark or his hides or skins, in large or small quantities, according to his uses for it, and they are many about a tannery or currying shop.

One reason of the growing use of borax is its steady fall in price during the past fifty years from 76 cents a pound in 1847 to 5½ cents a pound in 1897, one-fifteenth of its cost fifty years ago.

The following table shows the range of the average New York wholesale price of borax during the past fifty years:

	Cts.		Cts.		Cts.
1847	per lb..76	1864	per lb..39	1881	per lb..13¾
1848	72	1865	37½	1882	13¾
1849	70	1866	33	1883	14¾
1850	68½	1867	35½	1884	9¾
1851	67¼	1868	33⅓	1885	8¼
1852	66	1869	35	1886	6¾
1853	65	1870	30½	1887	5¾
1854	64½	1871	31¼	1888	7
1855	60½	1872	32	1889	7½
1856	57	1873	24⅝	1890	7½
1857	56¼	1874	14⅕	1891	7½
1858	54	1875	12⅝	1892	7½
1859	50	1876	10⅞	1893	7½
1860	48	1877	9¾	1894	7
1861	45	1878	8⅞	1895	6½
1862	42	1879	9	1896	5½
1863	40	1880	12¼	1897	5½

Borax, in addition to its many other uses in the currying shop, is also employed for cutting the oils and fats used in stuffing leather, it having displaced sal soda, chip soap, soapine and all other alkalies for this purpose. Borax is also used in the best known mordants for colored leathers. It "bites" or mordants the hides or skins uniformly, and is not harsh in its action, because it is so gentle an alkali. This is the chief cause of its popularity with the leather dyer. This gentleness makes its value in the kid industry to neutralize the excess of fat liquor and to wash all leather tanned by the chrome process, this washing giving a more uniform color and lustre to the skins after coloring or dyeing. A recent writer has truly said that it is not easy to convince any old tradesman that a better mode can be found than the one he has practiced all his life and all his ancestors before him. Some tanners have quoted the maxim, "leave well enough alone," adding, "we have done so well by

the old mode, we shall not make any change." But you will have to make a change. Modern business is done on a different plane from the business of the past. It is now truly a fight, a battle in fact—the fighting is done with the brain—and the man who survives is the one who watches to see if any economy can be practiced or any saving be made in any of the departments of his tannery or currying shop.

A most important use of borax in the tanning trade is its employment in softening the water for its soaks, cleansing and preserving the hides and skins and preventing the withdrawing of their gelatine, thus making heavier, more solid and more salable leather.

There are two reasons why the tanners of all kinds of hides and skins should use it in their soaks, as the soaks are always kept fresh and prevented from becoming putrid or foul, and thus withdrawing valuable gelatine from the hide or skin under treatment. Borax can be used not only in the soaks, but in the limes and bates as well. Its antiseptic qualities keep all of these liquors fresh and sweet. It renders water beautifully clear, sweet and soft, and just in the right condition for the soaks, just right for the leaches, for scouring and for the final cleansing of the hide or skin preparatory to placing it in the tanning liquor. Borax removes all taint, dry rot or decomposition from the hide or skin, and all other unhealthy changes, and produces a leather which will repay the tanner or currier ten times over for its use. It kills the bacilli of anthrax when used in the soaks, as it thoroughly disinfects the hide or skin, which is exposed to its action. We will speak of anthrax later on. Borax can be used in all climates and in all waters, hard, soft or sea water, and will instantly destroy all unhealthy and infectious germs wherever located, and in whatever part of the hide, skin or tanning material they may be. It will remove all dirt quickly, as it is one of the most perfect of cleansers, and will prepare the hide or skin for the reception of the tanning liquor more thoroughly than any other agent. In the rinsing or cleansing of the hide or skin preparatory to placing it in the tanning liquor, borax will be found to be the cheapest, most harmless and most efficient of the cleansing agents. In the leaches, borax will be found to be a very efficient agent for softening the water, as hard water has to have its hardness overcome by the tannic acid in the bark before it can become efficient for leaching the bark. Caustic soda and similar chemicals may be used for softening water; they are cheaper than borax, but will not do the work so efficiently, as they all withdraw the gelatine from the skin or hide, and thus make a soft and

less salable leather. Borax is, therefore, a cheap agent. The antiseptic qualities of borax preserve the liquors and keep them fresh and sweet, and at the same time, it being an alkali, very gentle fermentation of the bark is caused, so as fully to extract the tannin and to allow it to enter into combination with the hide or skin without becoming crystallized. It is this fact which makes borax so valuable for softening water for leaching tan bark. Borax is the material which is depended upon in nearly all the so-called quick tanning processes to do the work in aiding the penetration of the tannin. It improves and at the same time cheapens all leather produced. Leather is made in the beam house—not in the tanyard. If you lose the gelatine in the soaks, limes or bates it can never afterward be replaced in the hide or skin, and the result of tanning will only be an inferior leather. Borax stands alone in its antiseptic, decay-arresting, purifying attributes. Tanning belongs to those industries in which the decomposition of organic materials by micro-organisms plays an important role. The following recognized putrefactive ferments have been met with in tan liquors: Bacillus fluorescens liquefaciens (Flugge); B. megatherium (De Bary); B. subtilis (Ehrenberg); potato bacillus; B. mesentericus fuscus (Flugge); B. mycoides (Flugge); B. viscosis (Frankland); gas-forming bacillus (Eisenberg); white bacillus (Maschek); proteus vulgaris, proteus mirabilis (Hauser); Bacillus butyricus (Hueppe); white streptococcus (Maschek); worm-shaped streptococcus (Maschek); chey coccus (Maschek). Besides these known species there are other yet undescribed, but putrefactive organisms, most of which have a similar effect on the subsequent fermentation. They naturally occur most numerously in the weak liquor. As an example of the way certain bacteria get into a tannery, the following is given: The waste water of a large works discharged into a neighboring river was found to contain large numbers of proteus vulgaris and B. fluorescens liquefaciens; the same bacteria were found not only in the water, but in the limes and tan liquors of a tannery a mile down stream, drawing its waters from the same river. Where the cold-sweat process of unhairing is used a still larger number of putrefactive organisms are found in the liquors. Oak-wood and quebracho extracts, which ferment with difficulty, owing to a lack of suitable nutrient material, are good growing ground for molds. Their special function is the decomposition of tannins of a glucoside character. It will be seen from the above mentioned organisms that the souring of the tan liquors is influenced by numerous fac-

tors, and is no regular fermentation, such as alcoholic or acetic acid fermentation. A bacteriological examination of the liquors has shown a whole series of bacteria and fungi in the liquors, but chemical analysis shows the following to be the chief products: Carbonic acids, ethyl alcohol, acetic acid and lactic acid. Although all these are of equal theoretical importance, only the two latter are to be considered, and the bacteriological research is much simplified by considering only those species which produce these two acids. Of the two, lactic swells the skin better than acetic acid. The chemist who made this examination in Germany found no organism in tan liquors capable of fermenting glucose direct to acetic acid, and he considers that the production of this acid in the liquors is the result of two distinct processes: (1) the formation of alcohol; (2) the oxidation of the alcohol to acetic acid; that lactic and acetic acids are the result of entirely different chemical processes, and are produced by different organisms. The present generation need fear no scarcity of hemlock or oak bark. The question of the day in the struggle for economical results in the tanning industry is leaching. Many tanners delude themselves with the idea that they are getting the best results possible considering the conditions under which they are working, and by an occasional analysis of their spent tan they apparently prove their position. The results to be obtained it must be admitted consist in the extraction of a maximum amount of tannin with a minimum amount of water. If the water is hard it will take more of it to do the leaching than if it is soft. Borax softens the water and allows it to take immediate hold of the tan bark. What we must seek to do in leaching is to pass the water through the bark and not around it. Water which has been softened with borax is more penetrating, when either hot or cold, than is water which has not been softened. In this country, in the leaching of oak bark, hemlock bark, canaigre and other tannins, hot water is generally employed. The temperature at which it goes on the head-leach is not material; anywhere from 100° to 140° F. will do, but its temperature should be gradually increased until the water is at the boiling point on the tail-leach. Only in this way can the maximum amount of tannin be obtained. The antiseptic qualities of borax preserve the bark liquors and keep them fresh. The word antiseptic is derived from anti (against), septikos (putrescency). As an antiseptic, borax stands pre-eminent, and may therefore well take the place of carbolic acid, vitriol, chloride of lime, creosote and arsenic, wherever employed. We do not care whether you depilate with lime, sulphide of

sodium or any other agent, either sole, belting, harness or upper leather of any kind, whether it is produced from hides or skins, it is necessary that the hide or skin should be clean before it is placed in the tan liquor. Sour liquor will not then be required to overcome the depilitant. Then feed the hide or skin regularly; do not check it with too much liquor or too strong a liquor, or starve it by withholding supplies. Remember that there is no vacuum of time when the hide or skin is not feeding. If it is not fed continuously it will exude and lose its gelatinous matter, and this matter, once lost, can never be recovered or replaced. Borax is the only substance which will properly prepare the hide or skin for the reception of the tannin liquor. Then, too, borax is one of the best agents for softening water to be used on hides and skins preparatory to stuffing. To obtain a fine grain color the leather must be moistened, and must contain a certain amount of water when the oil or fat is put on, so as to resist the penetrating properties of the oil or fat, which can only be absorbed as the water is slowly evaporated. Do not make the mistake of greasing the hide or skin on both sides; this will prevent the evaporation of the water and the penetration of the oil or fat. Water which has been softened with borax has just a trace of this alkali in it, but enough to assist the penetration of the oil or fat. This applies to both hand and drum stuffing. In dyeing leather, the use of soft, bright, clear water permits of the getting of good colors, particularly when there are bright shades. In fact, where any alkali is now employed in the tannery or currying shop, it will be found that borax will take its place and will give more satisfactory results and better leather. The harness leather men and fancy leather manufacturers, and, in fact, all makers of leather, are already using borax extensively, and now it is so cheap as to be within the reach of all leather producers. For grain, split, buffed, patent, enamel, furniture, in fact, any leather which requires a smooth split, there is no agent as good as borax, to be used in dampening before splitting. The use of boracic acid as a bate for chrome tanned has been explained on page 335, and hence needs no special description here. Borax is largely used in the process of chrome tannage for washing the hides and skins after they come from the chrome liquor. They should then be well washed in warm water, then in 1 to 1½ per cent. of borax solution, and finally again in water. They are then ready to be fat liquored, stained, colored, set out, oiled off, etc., and finished.

ANTHRAX.

Acting upon the request of the Secretary of Agriculture, the Treasury Department has requested the Secretary of State to instruct all consular officers of the United States to refuse authentication of invoices of hides of meat cattle from districts in which anthrax exists. This request is made in view of the fact that a number of deaths of human beings and cattle recently occurred at Falls Creek, Pa., in consequence of the manipulation of hides in tanneries at that place.

Much apprehension has been awakened in the United States during the past few years by the supposed appearance of anthrax. Anthrax in its most malignant form exists in the countries of southern Europe and the Orient. Cattle, sheep, goats, and once in a while the horse, are attacked by the disease, which manifests itself as a splenic fever in those animals.

Unfortunately, the disease is easily conveyed to man in any climate, but only through inoculation. The medium through which man may be afflicted is the hair, wool or hides of any animal which has died of the disease. If a man's hand should have an abrasion and he should be among infected hides, the specific bacillus of anthrax may inoculate him where the abrasion is. In man its manifestation is variously described as malignant pustule, contagious carbuncle, wool sorters' and hair combers' disease.

It is therefore known in the human subject as a "wound disease." Unless the treatment is speedy the inoculation is rapidly followed by a virulent form of local inflammation, attended with sloughing and speedy systematic poisoning. The dust of infected wool or hair invades the throat and windpipe in wool sorters' disease, causing inflammation, poisoning all the surrounding tissues, and ending life by most distressing symptoms. After the inoculation there is great prostration, and death follows in a day or two from exhaustion.

Naturally, health boards of seaport cities are anxious to have a thorough inspection of all hides, wool and hair imported. There are very rare instances of anthrax in New York City, but it will be found on the records of the hospitals that there are perhaps a half dozen cases every year.

The New York City health authorities have been on their guard, and there is a constant inspection of incoming hides, hair and wool. President Wilson, of the Health Board, says that there is no ground for fear of anthrax because of its supposed appearance in other parts of

the country. On the subject of anthrax Dr. H. M. Biggs, the chief bacteriologist of New York city, says:

"In the human subject the disease is not necessarily fatal. If there is a rapid treatment after inoculation the patient generally recovers. The treatment is excision or the cutting out of the diseased flesh. There are few cases, and the element of danger is extremely small.

"There are no marked external indications of the disease in cattle. Once started, it may go through whole pastures."

Among the earliest of Pasteur's works was the preparation of an anthrax vaccine to prevent the spread of the disease in animals. The vaccination has resulted in an inestimable amount of benefit, and the human race has been saved from a serious danger. It is one of the monuments to the name of Pasteur.

The disease in cattle may originate in the food. The bacillus is most persistent. There is no time limit to its existence in hides, hair and wool. It will offer danger for years.

The spores of the bacilli are used as tests for disinfectants, and, as has been previously stated, borax, when used as a preservative for the hides and skins, or in the soaks, will kill them.

DEGRAS.

Degras, the kind made from wool washing, not the French degras, is used in finishing three-quarters of the American finished upper leather, of which nearly $9,000,000 worth was exported from the United States in 1896. This export business is rapidly increasing. Degras imparts peculiar qualities to the leather that no other greases and no oils can give; in fact, after the hide and bark, it is the principal article used in the manufacture of upper leather. Some tanners have tried to substitute menhaden oil for degras, but with only poor results.

The manufacturer of good upper leather can not afford to use menhaden oil at any price, as it contains a gummy substance that is likely to fry out when the leather has been finished a short time. This in export leather would be fatal. In the old days, when "anything was good enough for leather," menhaden oil was used, but with only disastrous effects, as the oil became gummy, and, when the leather was rolled up for a little while, the rolls could not be opened because the sides were so stuck together by this gum or fish glue. The leather manufacturer who would go back to menhaden oil would ignore the improvements which have been made in his craft during the past twenty-five years.

The Japan fish oil, which is being used to some extent, we are informed, is not like cod oil made from livers, but is similar to menhaden oil, a product of pressing the whole fish; and hence, when it is used for leather, the leather will gum or stick together when rolled similar to menhaden oil, the only difference being that the Japan fish oil takes a little longer time to stick the leather together, probably from having less fish-glue in it.

AMERICAN DEGRAS FROM WOOL WASTE.

Real degras is the oxidized fish oil wrung from chamois skins during the process of tannage, and it is imported from France. An imitation degras is made from wool waste, and is very largely imported from England and Germany.

The United States manufactures degras from wool waste in small quantities, but is about to embark in its production on a larger scale, and, strange to say, it is driven to do this because of the low price of wool.

The opponents of a tariff on wool assert that the great decline in the market price of wool is owing not to tariff legislation, but to the fact that the wool product of the world has doubled since 1870, and is also owing to the large utilization of cheap substitutes for wool.

An influence that may become a more potent factor in the near future, in increasing the availability of the present supply of wool, and thereby diminish the cost, is the promised solution of the vexed problem of the saving and utilization of the enormous wastes in the process of manufacturing. Recently it has been boldly asserted, and almost clearly demonstrated to a committee of wool manufacturers in Providence, that it is possible to utilize the by-products that now go to waste, so as to make them an important source of revenue to the manufacturer. At the same time, by this new process of cleaning, called the solvent process, the value of the fibre would be enhanced fully one cent a pound.

It is asserted that the amount of refuse material daily turned into the river by the wool manufacturers in the Olneyville, R. I., district is 6,000,000 gallons, in which are about 50,000 lbs. of grease; and besides a large quantity of logwood, acids and other substances, far in excess of what is generally supposed. The consumption of raw wool in this manufacturing district alone is estimated at 20,000,000 to 25,000,000 pounds per annum, and the committee stated that there was a loss of about 50 per cent. during the washing process.

According to statistics, there is a shrinkage of from 58 to 60 per cent. on some 500,000,000 pounds of wool annually consumed in the United States.

The startling announcement was made that the manufacturers were throwing away more money on the by-product than is produced by the wool product.

The man who made this statement gave, as an illustration, that they were putting into their streams 2,500,000 pounds of bicarbonate of potash and losing $250,000 annually. He also showed that in 25,000,000 pounds of wool there is 20 per cent. of wool fat, and therefore 5,000,000 pounds of degras is thus thrown away. There are now 11,000,000 pounds of degras imported into this country annually from Europe, and for every 5,000,000 pounds of wool consumed, $10,000 a year is paid for wool oil to put back into the wool.

The process proposed by Mr. N. Burton McDowell, of New York City, is effected by the introduction of a certain kind of oil in the cleansing pots. This oil is made by the Standard Oil Company, and can be used over and over again. A plant is now being erected to treat 16,000,000 pounds in Lawrence, Mass. The cost of the process, so far as the cleaning goes, is nil, or so nearly so that it counts for nothing. In addition, the cloth scourings are taken and treated for the indigo they contain. Mr. McDowell has offered to put in a proposition, accompanied by a bond, to take the wastes and treat them in the manner proposed, which the committee voted would be satisfactory.

This process, if successfully adopted, may work a revolution in the manufacturing of woolen fabrics, decreasing the cost of the raw material by enhancing its value, thereby giving a larger margin of profit to the mill owner while decreasing the cost of the manufactured product.

It would seem from the above statement that we have the greasy wools in this country, from which to make a degras equal to that which we now import from England and Germany.

THE PER CENT. OF WATER IN DEGRAS.

To determine the proportion of water in degras, says a correspondent of *La Halle aux Cuirs*, there are two methods in general use. The first consists of heating a previously determined weight of the degras in a clay crucible by means of a stove or a sand bath, and calculating the amount of water by the loss in weight. The temperature in this operation ought to be maintained at 221° F. If it rises to 239° or 247° F.,

it gives out whitish vapors of a pronounced odor, which evidently consist of something beside steam. Thus the chief objection to this method—that it gives results which are often too high—is not without foundation. If the operator does not have convenient access to a thermostat, or heating apparatus, which automatically maintains the temperature desired, it requires constant watchfulness and considerable loss of time.

The second method consists of agitating a given amount of degras in a graduated tube, with benzine, and leaving it until the water has separated itself, when the per cent. may be calculated by the graduations of the tube. The value of the results obtained by this process is also open to discussion. The water being separated, in a state of emulsion, it is impossible to exactly determine its actual volume. Owing to the different density of water and of fatty substance, the figures obtained will not coincide with those by the first method, and they are also influenced by the temperature maintained. In view of the many possibilities of error, it may be considered a happy chance if the result approximates the real amount sought to determine. In fact, by either system, different analyses of the same degras often present considerable variation.

Thanks to a very simple artifice, however, it is an easy matter to separate at the temperature of boiling water all the water which the degras contains. This may be accomplished by pouring upon the latter from time to time small quantities of concentrated alcohol, which evaporates the moisture from the warm liquid. A platinum capsule should be used to heat a few grammes of degras to the boiling point and a few cubic centimeters of alcohol used. When the last addition of alcohol is evaporated, the crucible is allowed to cool and the contents weighed ; then the operation may be repeated to make sure that no further shrinkage can be obtained.

This process does not require continual watchfulness, it takes less time and excludes any risk of overheating. The writer adds that he has already employed it for some months, and it has always given constant results. The idea is not absolutely new, as it has been employed in pharmacy for separating oleate of lead from its moisture.

TANNING MATTERS.

Our methods of determination of tanning matters are far from perfect, and, as Dr. W. Schmitz-Dumont truly says in *Der Ledermarkt:*

The accuracy of the results obtained in the analysis of tanning materials depends upon the quality of the hide-powder used. It is a matter of great difficulty to make or to obtain a hide-powder of uniformly good quality. In spite of the greatest caution observed in making the powder, the best hides often produce powders which are worthless, simply because they are not sufficiently insoluble in water or because their structure is too horny and gelatinous. The heating of the mill-stones during the grinding of the hide or the change in structure during the drying of the powder will account for the uncertain results. It is therefore desirable to obtain a substitute for hide powder, combining the following properties:

1. Absorption of tannic acid in the same manner as hide powder.
2. Insolubility in water.
3. It must be easily manufactured.

Experiments were first tried to separate tannin from solution by means of gelatin, hardened with alum and with chromic acid, but without success. The most satisfactory results were obtained with "formalin-gelatins." This is a commercial article, used as an antiseptic. It is a coarse, sandy powder, and absorbs tannin quantitatively and quickly, especially when the solution is heated to 104° F. But owing to the high price of the commercial article, and to its being contaminated with trioxymethylene (which has to be removed by long extraction with hot water, in order to prevent errors in the results), it seemed desirable to make this preparation in the laboratory. The following method was employed for making the "formalin-gelatin:"

Thick, woolly filter paper, free from soluble matter, is thoroughly impregnated with a hot 10 per cent. solution of gelatin, and placed horizontally on glass rods to dry in the air; it is then left for twenty-four hours in a 2 per cent. solution of formalin, and dried at 203° F. The sheets of paper now show a horny appearance, resembling celluloid; they are cut into strips and ground in a mill (a coffee mill will do). A woolly powder results, resembling hide powder in appearance.

This powder is again treated for twenty-four hours with a 2 per cent. formalin solution; the solution is then pressed out and the powder dried at 212° F., until the loss of weight is only 0.1 per cent. in thirty minutes' drying. The preparation must now be treated with hot water in a suitable extraction apparatus in order to remove the trioxymethylene; the extraction must be continued until 100 cubic centimeters of the extract give no reaction for formaldehyde with alkaline

resorcin solution. The water is then pressed out and the powder dried on the water-bath until it feels dry. Thirty grams of the preparation were treated with 400 cubic centimeters of water for twenty-four hours, with occasional shaking, in order to test it. 300 cubic centimeters of the clear filtered liquor on evaporation left a residue weighing 0.0023, an inconsiderable amount in a tannic acid determination.

A number of parallel determinations of tannic acid were made to compare the action of the gelatine compound with hide-powder. Twenty grams pine bark were extracted with one liter of water; 200 Cc. were shaken with each of the two absorbents. The manipulation with hide powder was according to the usual method. 200 Cc. of the extract solution were shaken for one hour with ten grams of the gelatine compound. The absorption proceeded more rapidly if the solution was warmed to 95 or 104 F.; in twenty minutes the solution was almost colorless, and gave only a faint reaction with ferric chloride. The solution was then filtered and left for twenty-four hours with ten grams of the gelatine preparation; filtered and dried to constant weight at 212° F.

The following amounts of non-tannins were obtained per 100 Cc. extract:

	Hide.	Gelatine.	Gelatine (heated).
Pine I	0.1599	0.1582	0.1589
	0.1576	0.1587	0.1580
Pine II	0.1630	0.1605	0.1621
	.....	.....	0.1613
Oakbark I	0.1895	0.1879	0.1888
"	0.1870	.....	.....
Oakbark II	0.1280	0.1269	0.1280
	.....	0.1277	.....

In evaporating the solutions of non-tannins, 5 grams of ignited quartz sand were added.

The results obtained were most favorable for the "formalin-gelatin;" but unfortunately a second preparation of it did not give as good results. The first preparation weighed only 300 grams; the second preparation amounted to two kilograms. Thirty grams of the new preparation, when treated for twenty-four hours with 400 Cc. water, gave 0.0063 grams residue per 100 Cc. A further treatment with water brought the weight of residue to 0.0102 grams per 10 Cc. It seems probable that in manipulating the larger quantity of material, the preparation was not

sufficiently dried to change the gelatine completely to the insoluble form. Or perhaps too long continued washing with water caused the compound to revert to the soluble form. Better methods of making the preparation will probably be suggested, so that it can be used as an infallible substitute for hide powder.

It is to be hoped that the International Conference of Leather Trades Chemists, which will be held in London on September 28 and 29, 1897, will be productive of much good, and that its decisions will regulate the commercial analysis of tanning materials till revised by a future meeting.

That this conference has high aims is shown by the following selection of subjects to be considered:

1. Standard method of drawing samples of (*a*) liquid extracts; (*b*) solid extracts, including gambier; (*c*) valonia; (*d*) algarrobilla and divi-divi; (*e*) general tanning materials.
2. Preparation of sample for analysis.
3. Preparation of infusion.
4. Method of determination of tanning matters.
5. Standard means of color measurement.

ELECTRIC TRANSMISSION OF POWER.

The direct application of power to machines by electric motors is a subject which has latterly claimed a good deal of the attention of tanners, and a number of them have introduced the "direct drive" in their establishments with very satisfactory results. The designers and builders of the electric motors are the Northern Electrical Mfg. Co., Madison, Wis., and the claims they make for their appliances are obvious and well worth the examination of all users of machinery. They calculate that the motors save thirty per cent. of floor space, compared with line shaft transmission. A number of machines with line shafting use up nearly double the floor space they would otherwise occupy, and then they frequently are placed at great disadvantage with reference to the handling of raw material and the manufactured product, and in relation to other machines performing kindred work. With the "direct drive" each machine may be located absolutely at the will of the manufacturer. Besides the better arrangement of the mechanism, there is a large saving in hangers, shafts, belts, pulleys, etc., and also in power. It is estimated that in the average establishment there is a loss on power delivered from the engine of forty per cent.

The company claim that with their direct connection these losses should not exceed twenty per cent. of the total power delivered. When any machine is stopped, the consumption of power is stopped likewise.

Direct electric motor drive is also claimed to yield a further material gain arising from the increase in the daily output of each driven machine, and consequently a very material gain in the output per man throughout the entire force employed, thus greatly increasing the amount of manufactured product per dollar of wages paid. There is also an absolute control of speed. It may be made uniform or varied at will, thus enabling each machine to be operated at its most profitable speed.

The tan drums of the Pfister & Vogel Leather Co., Milwaukee, are driven with these motors, and the company say they are giving perfect satisfaction. E. C. Fisher & Co., Gowanda, N. Y., have equipped their tannery complete with electrical generators and special tannery motors and fixtures, and say:

"To say that we are pleased with the work you have done and the operation of your machinery, would scarce do the subject justice. We already note the manifest saving in power and labor through direct application of the power and the great convenience of placing the machinery. We are much pleased with the strength, compactness and ease of operation of the equipments, all of which go from the first start without any trouble or hindrance. You have solved the economy question for the tanners of the world, and we heartily recommend your equipments to the trade."

The Northern Electrical Manufacturing Co. have issued a useful pamphlet (catalogue No. 7) showing their devices as used in connection with tanning machines of various descriptions, and it is replete with valuable information on the subject.

TO DRESS STRAP, POCKET-BOOK, BAG, CASE AND WELT LEATHER AND FLEXIBLE SPLITS.

Soak the stock so as to wet it through and skive off the rough flesh. Then jack the sides well on the grain in order to impart as much smoothness as possible. Then split them for any substance required. After they are split shave them; afterward mill them; for every twenty-five sides give them five to six pounds of borax for thirty minutes; wash off clean; then add sumac with two pails of well scalded sumac

with water enough to make the mixture twenty gallons; add one pint of sulphuric acid to the sumac liquor and mill for two hours; wash off; give them one pound of oxalic acid dissolved in a pail of water; mill ten minutes more and wash off; take the sides out and slick them off, they are then ready for coloring. If coloring is not desired they will make nice russet leather by giving them one pound of muriate of tin before slicking them out; if the stock is for strap, half dry them and moss them well on the flesh, set them out well on the grain and tack them on frames; stretch them well when they are dry, strip them from the frames, trim and moss them on the flesh and jack, hang up and dry, then dampen them with a weak oxalic acid on the grain and glass them out smoothly; then give them a good seasoning of flaxseed; hang up and dry; when they are dry, roll them; then brush or felt on the grain and they are finished. If bag or pocketbook stock is wanted the sides should not be mossed, because mossing stiffens them and bag leather should be seasoned with egg albumen and milk or starch and milk, one-half pound starch and one pint of milk. If two ounces of gum arabic are mixed with every pail of seasoning, a better finish will be imparted. If black stock is wanted use blood albumen, five ounces to the pail, more or less, according to the stock. If it is coarse, use more blood with a little milk; when the stock is seasoned and dry, glaze it; then dampen it well on the grain, pack the sides down, cover them up, put a weight on them and let them lie from five to ten hours; then pebble them, and while they are damp grain them, hang up and dry; when dry, glaze, grain and felt or brush and they are finished. The splits that come off these sides, if heavy enough, can be put into flexibles. Mill and sumac them as you would sides, but give them no muriatic acid, and when they are milled slick them on the flesh side; when they are slicked out moss them on flesh, turn them over and slick them out well on the grain, and moss and tack them on the frames; when they are dry, trim, moss and jack both sides; then dry and they are finished. For welt leather skive the stock clean and jack the sides well, and then level them off with the machine; give them a good scouring on both sides out of warm water; afterward a good sumac liquor for twenty-four hours at 140° F.; slick them out half dry, then set out on the grain; give them a weak oxalic acid and a water stuffing on the grain, turn them over, strike them out tight on the flesh and give them a light stuffing; hang up when they are half dry, reset them and dry them out; then glass and brush them on both sides, when they are finished.

LIST OF PATENTS RELATING TO THE MANUFACTURE OF LEATHER, ISSUED BY THE GOVERNMENT OF THE UNITED STATES OF AMERICA, FROM JANUARY 1, 1884, TO AUGUST 31, 1897.*

PROCESSES AND COMPOSITIONS.

Extracts.

Patents for extracting tan are classed with those for extracting dye woods or drugs, the processes being substantially similar, as well as much of the apparatus. The patents here cited refer only to tan bark.

No.	Date.	Inventor.	Residence.
302,105	July 15, 1884.	Emile L. P. and Gustave C. Coez,	St. Denis, France.
393,976	Dec. 4, 1888.	M. Gross,	New York City.
394,191	Dec. 11, 1888.	J. H. Lorimer,	Philadelphia, Pa.
444,068	Jan. 6, 1891.	J. and W. N. Hutchings,	Warrington, England.
466,152	Dec. 29, 1891.	H. S. Blackmore,	Mt. Vernon, N. Y.
503,237	Aug. 15, 1893.	M. Heftler and G. Bernard,	Paris, France.
505,816	Oct. 3, 1893.	S. W. Cochran,	Lambertville, N. J.
510,132	Dec. 5, 1893.	Otto C. Hagemann,	New York City.
541,410	June 18, 1895.	W. Albach,	Hochst, Germany.
571,635	Nov. 17, 1896.	John S. Adriance,	New York City.

Depilating.

No.	Date.	Inventor.	Residence.
291,953	Jan. 15, 1884.	A. H. Stone,	New York City.
306,640	Oct. 14, 1884.	P. H. P. Goulet,	Reims, France.
319,136	June 2, 1885.	E. Schroeder,	San Francisco, Cal.
322,521	July 21, 1885.	T. R. Clark,	New York City.
330,715	Nov. 17, 1885.	S. R. Kennedy,	Philadelphia, Pa.
330,790	Nov. 17, 1885.	S. R. Kennedy,	Philadelphia, Pa.
434,645	Aug. 19, 1890.	J. Schmitt,	Allegheny, Pa.
450,032	April 7, 1891.	J. Perl,	Berlin, Germany.
481,516	Aug. 23, 1892.	R. L. Tudor,	Cincinnati, O.
490,791	Jan. 31, 1893.	J. Mellinger,	Waverly, Md.
499,134	June 6, 1893.	J. Mellinger,	Baltimore, Md.
519,345	May 8, 1894.	C. L. Puech,	Mazamet, France.
520,005	May 15, 1894.	J. Mellinger,	Baltimore, Md.
545,560	Sept. 3, 1895.	G. C. Walter,	Hastings, Mich.
555,050	Feb. 18, 1896.	Pierson and Moor,	Philadelphia, Pa.

* The first edition of this book, published November 22, 1884, contains the Lists of Patents issued by the Government from 1790 to 1883, inclusive.

Bating.

No.	Date.	Inventor.	Residence.
461,010	Oct. 13, 1891.	C. W. Cooper,	Brooklyn, N. Y.
359,360	Mar. 15, 1887.	E. P. Nesbit,	Surrey, England.
411,034	Sept. 17, 1889.	A. Hull,	West Winsted, Conn.
413,615	Oct. 22, 1889.	W. Dieterle,	Feuerbach, Germany.
444,771	Jan. 13, 1891.	M. Wilson,	Becket, Mass.
450,930	April 21, 1891.	W. Dieterle,	Feuerbach, Germany.
450,954	April 21, 1891.	W. Oetlinger,	Philadelphia, Pa.
452,271	May 12, 1891.	Hull and Burns,	Boston, Mass.
455,851	July 14, 1891.	H. Poydenot,	Bayonne, France.
549,193	Nov. 5, 1895.	O. Geisler,	Gloversville, N. Y.
580,211	April 6, 1897.	W. Dieterle,	Feuerbach, Germany.

Tanning.

No.	Date.	Inventor.	Residence.
293,364	Feb. 12, 1884.	L. Schnadel,	Chicago, Ill.
300,352	June 17, 1884.	S. S. Eddy,	Rochester, N. Y.
302,132	July 15, 1884.	E. W. Hewitt,	Louisville, Ky.
304,958	Sept. 9, 1884.	J. Roberts,	Portville, N. Y.
309,701	Feb. 23, 1884.	S. S. Eddy,	Rochester, N. Y.
320,603	June 23, 1885.	E. S. Ward,	Newark, N. J.
326,753	Sept. 22, 1885.	G. H. Leonard,	Landisburg, Pa.
338,182	Mar. 16, 1886.	A. Muller,	New York City.
350,706	Oct. 12, 1886.	Mary Sutherland,	Diamond, Mo.
351,204	Oct. 19, 1886.	J. T. Rhyne,	Durant, Mo.
353,341	Nov. 30, 1886.	H. L. Wilcox,	Lincoln, Neb.
375,455	Dec. 27, 1887.	Millochau and Chailly,	Paris, France.
375,845	Jan. 3, 1888.	Waer, Phillips and Kengla,	Tucson, Arizona.
387,957	Aug. 7, 1888.	C. H. Perrin,	Jefferson City, Mo.
396,337	Jan. 15, 1889.	J. Lalor,	Independence, Ia.
411,931	Oct. 1, 1889.	G. H. Russell,	Newburg, Pa.
411,932	" "	"	"
435,922	Sept. 9, 1890.	T. L. Crafton,	Sidney, Ark.
447,427	Mar. 3, 1891.	W. E. Hedges,	Polk Bayou, Ark.
448,420	Mar. 17, 1891.	J. Engelke,	Cincinnati, O.
450,121	April 7, 1891.	C. B. Warrand,	Savannah, Ga.
450,998	April 21, 1891.	W. Dieterle,	Feuerbach, Ger.
453,295	June 2, 1891.	J. T. Smith,	San Francisco, Cal.
459,993	Sept. 22, 1891.	H. Churchill,	Rochester, N. Y.
461,108	Oct. 13, 1891.	R. W. Turner,	Dublin, Texas.
464,423	Dec. 1, 1891.	Brown, Clark and Brown,	South Fork, Mo.
473,805	April 26, 1892.	S. W. Wright,	Mountain Grove, Mo.
504,013	Aug. 29, 1893.	W. Zahn,	Newark, N. J.
517,083	Mar. 27, 1894.	C. B. Warrand,	Savannah, Ga.
526,229	Sept. 18, 1894.	J. B. Hodges,	Salem, Ark.
528,427	Oct. 30, 1894.	D. A. Goodman,	Salisbury, N. C.
536,019	Mar. 19, 1895.	S. and G. Durio,	Turin, Italy.
539,488	May 21, 1895.	W. A. Ragland,	Springfield, Mo.
542,680	June 16, 1895.	H. A. Leverett,	London, England.
555,028	Feb. 18, 1896.	J. H. Thompson,	Columbus, Ind.
562,781	June 23, 1896.	J. Durio,	Turin, Italy.
564,086	July 14, 1896.	C. Knees,	Oshawa, Canada.

*Tawing.**

No.	Date.	Inventor.	Residence.
291,784	Jan. 8, 1884.	A. Schultz,	New York City.
291,785	Jan. 8, 1884.	A. Schultz,	New York City.
323,973	Oct. 27, 1885.	G. F. Schweitzer,	Lincoln, Neb.
331,942	Dec. 8, 1885.	T. R. Clark,	New York City.
340,199	April 20, 1886.	S. J. Dobson,	Lincoln, Neb.
343,166	June 8, 1886.	J. W. Fries,	Salem, N. C.
343,167	June 8, 1886.	J. W. Fries,	Salem, N. C.
345,827	July 20, 1886.	J. S. Bilwiller,	St. Gall, Switzerland.
349,589	Sept. 21, 1886.	G. W. Hersey,	Empire, Wis.
367,145	July 26, 1887.	C. Kuestner,	Magdeburg, Prussia.
381,730	April 24, 1888.	J. Townsend,	Glasgow, Scotland.
381,734	April 24, 1888.	Warter and Koegel,	Newark, N. J.
383,379	May 22, 1888.	Snow and Howard,	Wichita, Kansas.
385,222	June 26, 1888.	W. Zahn,	Newark, N. J.
389,150	Sept. 4, 1888.	J. Hoelck,	Chicago, Ill.
401,434	April 16, 1889.	J. W. Hitt,	Lisle, N. Y.
401,715	April 16, 1889.	Erik Olstad Ollestad,	St. Paul, Minn.
409,336	Aug. 10, 1889.	L. Rappe,	Newark, N. J.
442,684	Feb. 16, 1890.	A. F. Krueger,	Kankakee, Ill.
451,385	April 28, 1891.	J. H. McWhirter, Langley and Upton,	Moody, Mo.
455,674	July 7, 1891.	G. C. Walter,	Hastings, Mich.
456,855	July 28, 1891.	C. L. Royer,	Halifax, England.
472,701	April 12, 1892.	H. Endemann,	Brooklyn, N. Y.
495,028	April 11, 1893.	M. Dennis,	Brooklyn, N. Y.
498,067	May 23, 1893.	A. D. Little,	Boston, Mass.
498,077	May 23, 1893.	W. M. Norris,	Princeton, N. J.
498,214	May 23, 1893.	W. M. Norris,	Princeton, N. J.
501,586	July 18, 1893.	J. W. Clayton,	Barren Fork, Ark.
504,012	Aug. 29, 1893.	W. Zahn,	Newark, N. J.
504,014	Aug. 29, 1893.	W. Zahn,	Newark, N. J.
506,696	Oct. 17, 1893.	J. H. James,	Nashville, Ark.
511,007	Dec. 19, 1893.	W. Zahn,	Newark, N. J.
511,301	Dec. 19, 1893.	W. F. Lawley,	Kennedy, Ala.
511,411	Dec. 26, 1893.	M. Dennis,	Newark, N. J.
518,467	April 17, 1894.	W. M. Norris,	Princeton, N. J.
528,162	Oct. 30, 1894.	C. Heinzerling,	Frankfort-on-Main, Germany.
542,971	July 16, 1895.	O. P. Amend,	New York City.
556,325	Mar. 10, 1896.	S. P. Sadtler,	Philadelphia, Pa.
561,044	May 26, 1896.	S. Chadwick,	Philadelphia, Pa.
563,559	July 7, 1896.	T. E. Burlingame,	Central Falls, R. I.
563,560	" "	"	"
563,561	" "	"	"
564,106	July 14, 1896.	J. C. Rogers,	Cuero, Texas.
573,362	Dec. 15, 1896.	H. Schweitzer,	Englewood, N. J.
573,631	Dec. 22, 1896.	G. W. Adler,	Philadelphia, Pa.
574,014	Dec. 29, 1896.	Wagner and Maier,	Philadelphia, Pa.
579,000	Mar. 16, 1897.	C. Marter,	London, England.
582,960	May 18, 1897.	J. A. Schweitzer,	Stains, France.
588,874	Aug. 24, 1897.	W. M. Norris,	Princeton, N. J.

* The conversion of hides and skins into leather by the aid of mineral substances.

Currying.

No.	Date.	Inventor.	Residence.
337,289	Mar. 2, 1886.	J. A. J. Schultz,	St. Louis, Mo.
399,893	Mar. 9, 1889.	J. J. Hayward,	Ballston, N. Y.
408,360	Aug. 6, 1889.	A. Sommer,	Berkeley, Cal.
449,437	Mar. 31, 1891.	W. B. Davis,	Newport, N. Y.
458,132	Aug. 18, 1891.	G. C. Seeberger,	Munchberg, Germany.
467,200	Jan. 19, 1892.	F. Riegert,	St. Joseph, Mo.
482,199	Sep. 6, 1892.	J. Sanzenbacher,	Canfield, O.
526,769	Oct. 2, 1894.	J. E. M. Bourgeois,	Paris, France.
547,985	Oct. 15, 1895.	B. P. Bradford,	Worcester, Mass.

Preserving.

No.	Date.	Inventor.	Residence.
341,583	May 11, 1886.	F. Latulip,	Syracuse, N. Y.
Reissue 10,792	Dec. 21, 1886.	F. Latulip,	Syracuse, N. Y.
361,999	April 26, 1887.	Grether and Mosher,	South Bend, Ind.
503,235	Aug. 15, 1893.	F. Groguet,	Bourbevoie, France.
503,987	Aug. 29, 1893.	G. Ruemeliu,	Milwaukee, Wis.
552,497	Dec. 31, 1895.	E. Menowsky,	New York City.

Coloring and Polishing.

No.	Date.	Inventor.	Residence.
295,653	Mar. 25, 1884.	L. Klopfer,	Munich, Germany.
325,320	Sep. 1, 1885.	G. S. Colburn,	Gardner, Mass.
329,960	Nov. 10, 1885.	A. Schmitt,	New Orleans, La.
346,581	Aug. 3, 1886.	E. Z. Coffee,	Philadelphia, Pa.
363,420	May 24, 1887.	J. Prickett,	Pittsfield, Mass.
365,854	July 5, 1887.	H. C. Parker,	Wilmington, Del.
378,325	Feb. 21, 1888.	C. L. Leonard,	Grafton, Mass.
381,680	April 24, 1888.	L. C. Dewillers,	Brooklyn, N. Y.
383,511	May 29, 1888.	A. S. Ashcroft,	Brandenburg, Ky.
397,803	Feb. 12, 1889.	S. C. Howell,	Newark, N. J.
401,390	April 16, 1889.	C. D. St. Pierre,	Brooklyn, N. Y.
402,731	May 7, 1889.	E. Frid,	New Hamburg, N. Y.
405,763	June 25, 1889.	G. H. Bishop,	Revere, Mass.
406,102	July 2, 1889.	G. Langenhagen,	Leipzig, Germany.
406,901	July 16, 1889.	W. E. Harter,	West Nanticoke, Pa.
418,414	Dec. 31, 1889.	G. T. Landauer,	Frankfort on Main, Ger.
425,919	April 15, 1890.	Wallace and Wallace,	Clay Center, Neb.
432,853	July 22, 1890.	Baulch, Steele and Evans,	St. Louis, Mo.
438,470	Oct. 14, 1890.	W. W. Crooker,	Lynn, Mass.
439,607	Jan. 28, 1890.	O. H. Shaw,	Toms Brook, Va.
441,010	Nov. 18, 1890.	J. M. Jolly,	Martin, Texas.
449,339	Mar. 31, 1891.	G. P. Tipton,	Hot Springs, Ark.
451,427	April 28, 1891.	J. W. Foster,	Detroit, Mich.
Reissue 11,144	Feb. 10, 1891.	W. W. Crooker,	Lynn, Mass.
458,828	Sep. 1, 1891.	G. H. Farthing,	San José, Cal.
466,429	Jan. 5, 1892.	W. F. Sampson,	Saugus, Mass.
469,385	Feb. 23, 1892.	W. W. Crooker,	Lynn, Mass.
473,679	April 26, 1892.	J. F. Thompson,	Rockland, Mass.
474,702	May 10, 1892.	J. E. Swain,	Baltimore, Md.

No.	Date.	Inventor.	Residence.
492,836	Mar. 7, 1893.	J. Riegert,	St. Joseph, Mo.
494,514	Mar. 28, 1893.	J. F. Thompson,	Rockland, Mass.
501,311	July 11, 1893.	Albertson and Briggs,	Rockland, Mass.
501,312	July 11, 1893.	Albertson and Briggs,	Rockland, Mass.
504,339	Sep. 5, 1893.	Z. T. Fowler,	Santa Rosa, Cal.
536,966	April 2, 1895.	R. Owens,	Orleans, Cal.
539,323	May 14, 1895.	Woods and Maclay,	Wurtsborough, N. Y.
542,188	July 2, 1895.	R. Ergang,	Magdeburg, Germany.
545,505	Sep. 3, 1895.	F. A. Hurd,	Red Bank, N. J.
545,734	Sep. 3, 1895.	J. Scholl,	Brooklyn, N. Y.
546,876	Sep. 24, 1895.	J. B. Bernard,	St. Paul, Minn.
555,537	Mar. 3, 1896.	Stevens and Schroeder,	Arago, Oregon.
572,439	Dec. 1, 1896.	Jane Moore,	Cambridge, Mass.
576,918	Feb. 9, 1897.	A. L. Thompson,	Rock Creek, O.
583,871	June 1, 1897.	Travis and Early,	Peabody, Mass.
588,000	Aug. 10, 1897.	Wm. M. Norris,	Princeton, N. J.
588,471	Aug. 17, 1897.	H. A. Quigley,	Milford, N. H.

APPARATUS.

Coloring and Polishing.

No.	Date.	Inventor.	Residence.
320,906	June 30, 1885.	F. B. Batchelder,	Malden, Mass.
322,606	July 21, 1885.	J. Hodskinson,	Salem, Mass.
385,933	July 10, 1888.	I. G. Hooper,	Newark, N. J.
427,697	May 13, 1890.	J. Kristen,	Brunn, Moravia.
436,363	Sep. 16, 1890.	A. Travis,	Gloversville, N. Y.
442,628	Dec. 23, 1890.	T. J. Faulkner,	Lynn, Mass.
456,605	July 28, 1891.	A. Travis,	Gloversville, N. Y.
477,761	June 28, 1892.	C. Knabe,	Osterwieck, Germany.
498,120	May 23, 1893.	A. F. Jones,	Salem, Mass.
504,224	Aug. 29, 1893.	C. H. and A. A. Lappe,	Allegheny, Pa.
513,642	Jan. 30, 1894.	A. F. Jones,	Salem, Mass.
542,439	July 9, 1895.	Enos and Pratt,	Peabody, Mass.
578,060	Mar. 2, 1897.	C. E. House,	Yates, Mich.
579,141	Mar. 23, 1897.	R. N. Dunn,	Philadelphia, Pa.

Leather Measuring.

No.	Date.	Inventor.	Residence.
329,596	Nov. 3, 1885.	W. A. Sawyer,	Danversport, Mass.
329,597	Nov. 3, 1885.	"	"
514,821	Feb. 13, 1894.	J. E. Fortin,	Quebec, Canada.

Rossing Bark.

No.	Date.	Inventor.	Residence.
300,829	June 24, 1884.	F. F. Angermaier,	Ravensburg, Wurtemberg, Germany.
300,996	June 24, 1884.	F. Merziger,	Trier, Prussia.
305,322	June 24, 1884.	"	"
314,876	Mar. 31, 1885.	T. Poole and F. P. Snow,	Orange, Mass.
368,968	Aug. 30, 1887.	F. M. Purinton,	Providence, R. I.
379,559	Mar. 20, 1888.	N. H. Brokaw,	Kaukauna, Wis.
397,114	Feb. 5, 1889.	N. H. Dolsen,	St. Ignace, Mich.
416,784	Dec. 10, 1889.	T. F. Horn,	Livermore Falls, Me.

No.	Date.	Inventor.	Residence.
431,154	July 1, 1890.	F. H. and A. E. Stearns,	Eden, Vt.
489,178	Jan. 3, 1893.	R. P. Bloss,	Palmer, N. Y.
489,251	Jan. 3, 1863.	W. Hadley and A. T. McDonald,	Shelton, Conn.
510,795	Dec. 12, 1893.	W. W. D. Jeffers,	Ticonderoga, N. Y.
515,537	Feb. 12, 1894.	A. E. Stearns,	Eden, Vt.
516,091	Mar. 6, 1894.	E. C. Hargreave,	Bay City, Mich.
517,990	April 10, 1894.	W. W. and F. N. Trevor,	Lockport, N. Y.
528,664	Nov. 6, 1894.	C. E. V. Folin,	Hammerby, Sweden.
528,873	Nov. 6, 1894.	W. Hadley,	Shelton, Conn.
540,980	June 11, 1895.	E. C. Hargreave,	Bay City, Mich.
572,948	Dec. 15, 1896.	A. E. Beals,	Norwich, N. Y.
579,946	Mar. 30, 1887.	P. Etches,	Tupper Lake, N. Y.

Grinding Mills for Bark.

No.	Date.	Inventor.	Residence.
300,048	June 10, 1884.	L. B. Clark,	Springfield, Mass.
305,711	Sep. 23, 1884.	J. T. Phillips,	Grand Rapids, Mich.
321,725	July 7, 1885.	B. Holbrook,	Kenosha, Wis.
325,849	Sep. 8, 1885.	J. McKendrick,	New York City.
329,113	Oct. 27, 1885.	W. A. Woods,	Santa Cruz, Cal.
332,796	Dec. 22, 1885.	J. C. Hagerty,	" " "
332,797	Dec. 22, 1885.	"	" " "
332,854	Dec. 22, 1885.	W. A. Woods,	Santa Cruz, Cal.
334,859	Jan. 26, 1886.	J. C. Hagerty,	" " "
335,532	Feb. 2, 1886.	B. Ott,	La Crosse, Wis.
335,533	Feb. 2, 1886.	"	" " "
340,922	April 27, 1886.	"	" " "
351,178	Oct. 17, 1886.	B. Holbrook,	Milwaukee, Wis.
355,179	Dec. 28, 1886.	R. C. Kirby,	Santa Cruz, Cal.

Tan Vats.

No.	Date.	Inventor.	Residence.
308,803	Dec. 11, 1884.	R. Spitta,	Brandenburg-on-Havel, Prussia.
321,300	June 30, 1885.	T. Johnstonbaugh,	Clearfield, Pa.
324,916	Aug. 25, 1885.	Bull and Hill,	Limestone, N. Y.
328,984	Oct. 27, 1885.	T. R. Tuttle,	Salem, Mass.
332,451	Dec. 15, 1885.	L. Simpson,	Bellevue, Pa.
380,890	April 10, 1888.	J. Head,	York, Pa.
386,488	July 24, 1888.	A. A. Myers,	Lancaster, Pa.
483,734	Oct. 4, 1892.	B. P. Bradford,	Worcester, Mass.
510,500	Dec. 12, 1893.	T. Clarke,	Stockport, England.
514,549	Feb. 13, 1894.	W. T. Harrison,	Pooler, Ga.
571,678	Nov. 17, 1896.	A. A. Myers,	Lancaster, Pa.

Endless Belts.

No.	Date.	Inventor.	Residence.
331,085	Nov. 24, 1885.	A. W. Reid,	Ballston Spa, N. Y.
356,101	Jan. 18, 1887.	E. A. Curry,	Winchester, Mass.
389,511	Sept. 11, 1888.	W. M. Hoffman,	Detroit, Mich.
479,072	July 19, 1892.	A. A. Hunting,	Salem, Mass.
497,003	May 9, 1893.	Dawson and Schumacher,	Boston, Mass.
584,123	June 8, 1897.	W. B. Turner,	Somerville, Mass.

*Splitting.**

No.	Date.	Inventor.	Residence.
291,641	Jan. 1884.	T. S. Strong,	East Bridgewater, Mass.
295,629	Mar. 25, 1884.	H. S. Ginther,	Olney, Ill.
295,787	Mar. 25, 1884.	B. McKeen,	Peabody, Mass.
305,240	Sept. 16, 1884.	J. A. Safford,	Boston, Mass.
306,760	Oct. 24, 1884.	J. T. Krebs,	Cleveland, O.
319,357	June 2, 1885.	G. L. Tyler,	Lynn, Mass.
332,385	Dec. 15, 1885.	E. Cummings,	Woburn, Mass.
337,820	Mar. 16, 1886.	A. E. Dodge,	Woburn, Mass.
339,990	April 13, 1886.	J. A. Josselyn,	Brookfield, Mass.
342,983	June 1, 1886.	G. L. Tyler,	Lynn, Mass.
344,404	June 29, 1886.	C. E. Roberts,	Chicago, Ill.
345,007	July 6, 1886.	G. L. Tyler,	Lynn, Mass.
346,389	July 27, 1886.	A. F. Stowe,	Worcester, Mass.
347,402	Aug. 17, 1886.	A. G. Webster,	Boston, Mass.
353,235	Nov. 23, 1886.	A. F. Stowe,	Worcester, Mass.
358,081	Feb. 22, 1887.	T. Smith,	Cincinnati, O.
358,883	Mar. 8, 1887.	C. E. Roberts,	Chicago, Ill.
362,694	May 10, 1887.	H. Worcester,	Malden, Mass.
372,640	Nov. 1, 1887.	C. E. Roberts,	Chicago, Ill.
373,196	Nov. 15, 1887.	C. E. Roberts,	Chicago, Ill.
374,401	Dec. 6, 1887.	G. Faustman,	Philadelphia, Pa.
378,157	Feb. 21, 1888.	W. E. Adams,	Lynn, Mass.
378,158	"	W. E. Adams,	Lynn, Mass.
378,179	"	S. Ross, Jr.,	Newport, Ky.
378,185	Feb. 21, 1888.	G. L. Tyler,	Lynn, Mass.
378,186	"	"	" "
379,700	Mar. 20, 1888.	A. Hull,	New Boston, Mass.
381,075	April 10, 1888.	J. A. Josselyn,	Brookfield, Mass.
395,759	Jan. 8, 1889.	H. Stanley,	Swampscott, Mass.
Reissue 11,008	June 18, 1889.	H. Stanley,	Swampscott, Mass.
403,486	Mar. 14, 1889.	H. C. Pease,	Worcester, Mass.
405,697	June 25, 1889.	E. M. Dunphe and C. Blockhaus,	East Bridgewater, Mass.
413,093	Oct. 15, 1889.	J. A. Safford,	Malden, Mass.
420,152	Jan. 28, 1890.	C. S. Fifield,	Revere, Mass.
445,744	Feb. 3, 1891.	W. A. Bates,	Princeton, Me.
462,166	Oct. 27, 1891.	J. A. Safford,	Malden, Mass.
465,145	Dec. 15, 1891.	" "	" "
477,456	June 21, 1892.	" "	" "
477,457	" "	" "	" "
477,461	" "	" "	" "
477,462	" "	" "	" "
479,461	July 26, 1892.	S. H. Randall,	Wyoming, O.
514,730	Feb. 13, 1894.	J. A. Safford,	Malden, Mass.
537,912	April 23, 1895.	J. K. Bigelow,	San Francisco, Cal.
539,472	May 21, 1895.	J. E. Fairbanks,	Hillsdale, Mich.
542,740	July 16, 1895.	J. Robertson,	Woburn, Mass.
554,783	Feb. 18, 1896.	M. Leidgen,	Milwaukee, Wis.
561,360	June 9, 1896.	T. J. Bringham,	Chicago, Ill.
587,783	Aug. 10, 1897.	" "	" "
587,784	Aug. 10, 1897.	" "	" "
588,928	Aug. 24, 1897.	G. R. Rank,	Alleghany, N. Y.

* Including machines used in shoe factories.

Cutting, including Skiving, etc.*

No.	Date.	Inventor.	Residence.
296,219	April 1, 1884.	J. Roth,	Columbus, O.
296,781	April 15, 1884.	C. E. Ramus,	Chicago, Ill.
297,351	April 22, 1884.	G. W. Cody,	Hartford, Conn.
299,329	May 27, 1884.	H. A. Behn,	Union, N. J.
299,952	June 10, 1884.	R. Brownson,	St. Paul, Minn.
302,759	July 27, 1884.	A. Miller and J. M. Kailer,	Newark, O.
304,824	Sep. 9, 1884.	E. Johnson,	New Orleans, La.
307,127	Oct. 28, 1884.	W. Lufkin,	Chelsea, Mass.
310,527	June 6, 1885.	H. E. Koepka,	St. Johnsbury, Vt.
310,742	Jan. 13, 1885.	G. E. Stockwell,	Marblehead, Mass.
312,643	Feb. 24, 1885.	D. Knox,	Lynn, Mass.
313,167	Mar. 3, 1885.	R. Bowden,	Marblehead, Mass.
313,172	" "	N. W. Calhoun and J. G. Chambers,	Lena, Ill.
313,349	" "	F. R. Lewis,	Troy, N. Y.
314,474	Mar. 24, 1885.	T. M. Platts,	Newark, N. J.
316,006	April 21, 1885.	J. H. Busell,	Boston, Mass.
316,073	" "	C. F. Stackpole,	Lynn, Mass.
316,074	" "	C. F. Stackpole,	Lynn, Mass.
316,704	April 28, 1885.	J. M. Watson,	Sharon, Mass.
317,463	May 5, 1885.	D. Knox,	Lynn, Mass,
320,209	June 16, 1885.	E. F. Belding,	Fitchburg, Mass.
322,923	July 28, 1885.	T. Gingras,	Buffalo, N. Y.
323,061	July 28, 1885.	J. Murphy,	Brooklyn, N. Y.
323,860	Aug. 4, 1885.	M. V. Doyle,	Rockford, Ill.
325,037	Aug. 25, 1885.	Abbott and Luce,	Dedham, Mass.
328,317	Oct. 13, 1885.	J. Kirwin,	New York City.
331,293	July 28, 1885.	T. Gingras,	Buffalo, N. Y.
334,119	Jan. 12, 1886.	J. D. Hunphrey,	Towanda, Pa.
338,347	Mar. 23, 1886.	C. T. Grilley,	Boston, Mass.
343,238	June 8, 1886.	H. G. Foss,	Auburn, Me.
346,093	July 27, 1886.	H. H. Cummings,	Malden, Mass.
346,651	Aug. 3, 1886.	G. W. Cross,	Oxford, N. J.
350,753	Oct. 12, 1886.	E. A. Latham,	East Bridgewater, Mass.
352,139	Nov. 9, 1886.	J. Leuenberger,	Camden, O.
356,662	Jan. 25, 1887.	T. B. Raymond,	Rochester, N. Y.
356,793	Feb. 1, 1887.	J. W. Ringrose, and D. A. Hauck,	Mechanicsburg, Ill.
358,067	Feb. 22, 1887.	J. Parker and N. L. Gunning,	Williamsport, Pa.
358,779	Mar. 1, 1887.	N. B. Jones,	Murfreesboro, Ill.
361,707	April 26, 1887.	J. Matthieu,	Ottawa, Ill.
362,412	May 3, 1887.	W. E. Adams,	Lynn, Mass.
363,265	May 17, 1887.	J. N. Whitcomb,	Brockton, Mass.
363,461	May 24, 1887.	C. B. Hatfield,	Rochester, N. Y.
364,643	June 14, 1887.	A. D. Goetz,	Martinsburg, Pa.
367,709	Aug. 2, 1887.	F. Engel and C. Wagner,	Offenbach on Main, Ger.
368,108	Aug. 8, 1887.	H. Parsons,	Marlboro, Mass.
368,672	Aug. 23, 1887.	W. C. James,	Boston, Mass.
370,327	Sept. 20, 1887.	W. S. Fitzgerald,	Boston, Mass.
373,126	Nov. 15, 1887.	J. Burger,	Cincinnati, O.
375,372	Dec. 27, 1887.	G. Marsh,	Nashville, Tenn.
375,811	Jan. 3, 1888.	E. Gott,	Newton, Mass.
376,974	Jan. 24, 1888.	C. Wonderlich,	Washington, Mo.

* Including machines used in shoe factories.

No.	Date.	Inventor.	Residence.
381,696	April 24, 1888.	F. Hirsch,	New York City.
384,020	June 5, 1888.	P. B. Clark and G. J. Klingler,	Brooklyn, N. Y.
384,032	June 5, 1888.	F. E. Frost,	Lewiston, Me.
386,051	July 10, 1888.	G. H. Avery,	East Hampton, Mass.
390,551	Oct. 2, 1888.	E. F. Belding,	Fitchburg, Mass.
391,190	Oct. 16, 1888.	S. H. Randall,	Wyoming, O.
391,575	Oct. 23, 1888.	C. H. Bayley,	Boston, Mass.
392,673	Nov. 13, 1888.	A. D. Goetz,	Martinsburg, Pa.
394,111	Dec. 4, 1888.	O. G. Garlock,	Palmyra, N. Y.
399,965	Mar. 19, 1889.	J. Bradley,	Dundee, N. Y.
403,805	May 21, 1889.	S. Walder,	Buda-Pesth, Hungary.
404,949	June 11, 1889.	G. H. Avery,	East Hampton, Mass.
412,503	Oct. 8, 1889.	W. H. Hoople,	Brooklyn, N. Y.
417,268	Dec. 17, 1889.	J. G. McCartee,	Boston, Mass.
419,357	Jan. 14, 1890.	C. E. Ramus,	Chicago, Ill.
421,778	Feb. 18, 1890.	H. G. Starr,	Belvedere, Ill.
423,977	Mar. 25, 1890.	A. D. Worthen,	Sandown, N. H.
426,251	April 22, 1890.	G. F. Dunn,	Brockton, Mass.
426,577	April 29, 1890.	V. T. Whittlesey and A. B. Keyes,	New Haven, Conn.
427,461	May 6, 1890.	H. Comstock,	Fulton, N. Y.
427,579	May 13, 1890.	F. L. Kuhn,	Lunenburg, Mass.
427,610	May 13, 1890.	H. C. Pretty,	Leicester, England.
430,882	June 24, 1890.	J. O. Purnell,	Pittsfield, Mass.
432,641	Feb. 22, 1890.	C. E. Ramus,	Chicago, Ill.
435,381	Aug. 26, 1890.	H. T. Rohrmoser,	Hoboken, N. J.
439,208	Oct. 28, 1890.	A. J. Tewksbury,	Haverhill, Mass.
439,433	Oct. 28, 1890.	J. R. Scott,	Nyack, N. Y.
439,603	Oct. 28, 1890.	Randall.	
442,399	Dec. 9, 1890.	J. A. Safford,	Malden, Mass.
442,996	May 26, 1891.	B. F. Durham,	Brockton, Mass.
443,579	Dec. 30, 1890.	S. Hainkel,	Quincy, Ill.
443,409	Dec. 23, 1890.	J. R. Scott,	Nyack, N. Y.
445,588	Feb. 3, 1891,	H. C. Pease,	Worcester, Mass.
453,944	June 9, 1891.	J. R. Scott,	New York City,
458,535	Aug. 25, 1891.	W. H. Kimball,	Burlington, N. J.
459,231	Sept. 8, 1891.	C. S. Fifield,	Revere, Mass.
459,715	Sept. 15, 1891.	S. J. Talbott,	Milford, N. H.
465,840	Dec. 29, 1891.	A. Dewees and R. P. Trist,	Brooklyn, N. Y.
467,441	Jan. 19, 1892.	J. R. Scott,	New York City.
468,613	Feb. 9, 1892.	R. P. Trist,	Wilmington, Del.
470,015	Mar. 1, 1892.	J. R. Scott,	New York City.
470,016	" "	"	"
472,148	April 5, 1892.	A. J. Tewksbury,	Haverhill, Mass.
475,053	May 17, 1892.	L. M. Cabana,	Buffalo, N. Y.
477,458	June 21, 1892.	J. A. Safford,	Malden, Mass.
477,459	" "	"	" "
479,583	July 26, 1892.	C. H. Bayley,	Boston, Mass.
486,813	Nov. 22, 1892.	A. K. Washburn,	Bridgewater, Mass.
487,894	Dec. 13, 1892.	J. H. Shields,	Chicago, Ill.
488,212	Dec. 20, 1892.	H. Masterson,	Jefferson City, Mo.
488,324	Dec. 20, 1892.	P. W. Rodecker,	Sidney, O.
492,342	Feb. 21, 1893.	T. F. Tyler,	Lynn, Mass.
492,640	Feb. 28, 1893.	T. Thompson,	New London, Wis.
493,189	Mar. 7, 1893.	J. L. Scott,	New York City.

No.	Date.	Inventor.	Residence.
500,538	July 4, 1893.	A. J. Allen,	Essex, Canada.
501,207	Sept. 11, 1893.	T. Gingras,	Buffalo, N. Y.
503,341	Aug. 15, 1893.	M. E. Briggs,	St. Louis, Mo.
505,198	Sept. 19, 1893.	C. S. Fifield,	Revere, Mass.
505,598	Sept. 26, 1893.	Z. T. French and W. T. Meyer,	Boston, Mass.
506,573	Oct. 10, 1893.	J. M. Watson,	Sharon, Mass.
507,210	Oct. 24, 1893.	A. Buchholz,	Boeuf Creek, Mo.
512,953	Jan. 16, 1894.	J. Gerber,	Tremont, Mich.
515,927	Mar. 6, 1894.	E. B. Stimpson,	Brooklyn, N. Y.
517,631	April 3, 1894.	A. J. Tewksbury,	Haverhill, Mass.
518,774	April 24, 1894.	C. H. Bayley,	Boston, Mass.
518,790	April 24, 1894.	A. E. Perry,	Wakefield, Mass.
519,570	May 8, 1894.	H. A. Dodge and W. T. Richards,	Newton, Mass.
520,215	May 22, 1894.	T. A. Norris,	Brockton, Mass.
520,709	May 29, 1894.	J. R. Scott,	New York City.
520,851	June 5, 1894.	J. R. and O. Kempfe,	Brooklyn, N. Y.
521,048	June 5, 1894.	M. J. Ryan,	New Orleans, La.
521,068	June 5, 1894.	H. Wright,	Kettering, England.
521,077	June 5, 1894.	J. Barker,	Philadelphia, Pa.
521,090	June 5, 1894.	J. R. Scott,	New York City.
521,538	June 19, 1894.	P. Goldstein,	Newark, N. J.
521,583	June 19, 1894.	G. A. Cole and E. H. Taylor,	Lynn, Mass.
525,872	Sept. 11, 1894.	E. B. Stimpson,	Brooklyn, N. Y.
524,768	June 21, 1894.	Randall.	
526,617	Sept. 25, 1894.	F. E. Druschkey and L. A. Schyerling,	Chicago, Ill.
527,299	Oct. 9, 1894.	F. L. Stone,	Brockton, Mass.
527,928	Oct. 23, 1894.	C. H. Bayley,	Boston, Mass.
528,448	Oct. 30, 1894.	J. R. Scott,	New York City.
528,502	Oct. 30, 1894.	W. E. Bennett,	Boston, Mass.
531,069	Dec. 18, 1894.	L. K. Scotford,	Chicago, Ill.
531,744	Jan. 1, 1895.	T. A. Norris,	Brockton, Mass.
531,949	Jan. 1, 1895.	J. N. Kendall,	Nashua, N. H.
534,767	Aug. 21, 1894.	Randall.	
535,784	Mar. 12, 1895.	L. T. Barber,	Boston, Mass.
535,895	Mar. 19, 1895.	B. F. Hale,	Newburyport, Mass.
537,148	April 9, 1895.	J. B. Gathright,	Louisville, Ky.
537,913	April 23, 1895.	J. K. Bigelow,	San Francisco, Cal.
541,304	June 18, 1895.	P. Young,	Danbury, Conn.
541,691	June 25, 1895.	J. R. Scott,	New York City.
543,635	July 30, 1895.	A. S. Vose,	Providence, R. I.
543,792	July 30, 1895.	R. Wright and J. E. Parker,	Chicago, Ill.
548,101	Oct. 15, 1895.	S. Ward,	Princeton, Ind.
549,027	Oct. 29, 1895.	J. R. Scott,	Chicago, Ill.
549,216	Nov. 5, 1895.	E. Sawyer,	Barre, Vt.
550,805	Dec. 3, 1895.	E. Stimpson.	
551,872	Dec. 24, 1895.	W. A. Murray and H. Fitzsimmons,	Newark, N. J.
554,069	Feb. 4, 1896.	L. H. Liebe and J. A. Vanderpool,	San Jose, Cal.
557,276	Mar. 31, 1896.	W. B Keighley,	Vineland, N. J.
557,554	April 7, 1896.	E. V. Clemens,	New York City.

No.	Date.	Inventor.	Residence.
558,864	April 21, 1896.	E. Van Osla,	Louisville, Ky.
560,782	May 26, 1896.	J. Crydermann,	Milwaukee, Wis.
561,999	June 16, 1896.	W. Kootz,	" "
562,000	" "	W. Kootz,	" "
562,126	" "	H. Ellis,	St. Catherines, Can.
564,889	July 28, 1896.	E. Rahm,	Elberfeld, Germany.
567,130	Sep. 8, 1896.	P. Goldstein and G. Andae,	Newark, N. J,
567,131	Sep. 8, 1896.	P. Goldstein and G. Andae,	Newark, N. J.
570,164	Oct. 27, 1896.	F. J. Freese,	Montreal, Canada.
571,291	Nov. 10, 1896.	A. L. Sweet,	Chicago, Ill.
571,292	" "	" "	" "
571,293	" "	" "	" "
571,295	" "	" "	" "
573,274	Dec. 15, 1896.	H. Le Roy Kemp,	Camden, N. J.
575,821	Jan. 26, 1897.	H. F. Blake,	Haverhill, Mass.
578,547	Mar. 9, 1897.	E. F. Davenport,	Boston, Mass.
580,390	April 13, 1897.	J. H. Giffard,	Grand Rapids, Mich.
586,308	July 13, 1897.	B. F. Dunham,	Brockton, Mass.

Putting Out and Stretching.

No.	Date.	Inventor.	Residence.
308,171	Nov. 18, 1884.	R. S. Jennings,	Boston, Mass.
318,820	June 26, 1885.	Stone and Pratt,	Salem, Mass.
331,325	Dec. 1, 1885.	B. M. Plummer,	Philadelphia, Pa.
352,024	Nov. 2, 1886.	P. A. Jesson,	Paris, France.
Reissue 10,860	Aug. 23, 1887.	P. A. Jesson,	Paris, France.
378,066	Feb. 14, 1888.	W. M. Hoffman,	Detroit, Mich.
387,305	Aug. 7, 1888.	J. F. Ingraham,	West Peabody, Mass.
387,402	Aug. 7, 1888.	G. E. Danforth,	Lynn, Mass.
388,611	Aug. 28, 1888.	W. E. Adams,	Lynn, Mass.
392,141	Oct. 30, 1888.	N. Weber,	Lynn, Mass.
393,544	Nov. 27, 1888.	P. H. Daley,	Lynn, Mass.
395,727	Jan. 8, 1889.	N. Weber,	Lynn, Mass.
396,811	Jan. 29, 1889.	G. E. Danforth,	Lynn, Mass.
397,821	Feb. 12, 1889.	F. Storch,	Chicago, Ill.
402,860	May 7, 1889.	C. T. Royer,	Halifax, England.
416,918	Dec. 10, 1889.	M. N. Howard,	Brooklyn, N. Y.
423,030	Mar. 11, 1890.	G. E. Danforth,	Lynn, Mass.
423,846	Mar. 18, 1890.	West and Sinning,	St. Louis, Mo.
457,136	Aug. 4, 1891.	C. R. Stackpole,	Lynn, Mass.
457,331	Aug. 4, 1891.	G. V. Anderson,	Wilmington, Del.
501,593	July 18, 1893.	C. R. Stackpole,	Lynn, Mass.
538,914	May 7, 1895.	R. Holmes,	Cramer's Hill, N. J.
549,422	Nov. 5, 1895.	G. W. Baker,	Wilmington, Del.
549,423	Nov. 5, 1895.	G. W. Baker,	Wilmington, Del.
549,424	Nov. 5, 1895.	G. W. Baker,	Wilmington, Del.
553,682	Jan. 25, 1896.	L. Lichtenstein,	Wilmington, Del.
553,683	Jan. 25, 1896.	L. Lichtenstein,	Wilmington, Del.
580,865	April 20, 1897.	G. V. Hysore,	Wilmington, Del.
582,774	May 18, 1897.	C. Bouteon,	Paris, France.
585,212	Jan. 29, 1897.	A. F. Jones,	Salem, Mass.

Stretching Frames.

No.	Date.	Inventor.	Residence.
308,170	Nov. 18, 1884.	R. S. Jennings,	Boston, Mass.
335,595	Feb, 9, 1886.	A. C. Krueger,	Chicago, Ill.
357,609	Feb. 15, 1887.	H. G. Landers,	Protem, Mo.
372,228	Dec. 6, 1887.	J. Young,	Newark, N. J.
410,745	Sept. 10, 1889.	G. F. Stengel,	Newark, N. J.
414,283	Nov. 5, 1889.	B. P. Bradford,	Worcester, Mass.
440,358	Nov. 11, 1890.	P. King,	Washington, D. C.
446,794	Feb. 8, 1891.	W. Coupe,	Attleboro, Mass.
446,847	Feb. 24, 1891.	H. R. Behrens,	Worcester, Mass.
468,392	Feb. 9, 1892.	H. R. Behrens,	Worcester, Mass.
484,137	Oct. 11, 1892.	L. F. Cauffield,	Ashtabula, O.
490,338	Jan. 24, 1893.	L. F. Cauffield,	Ashtabula, O.
490,339	Jan. 24, 1893.	L. F. Cauffield,	Ashtabula, O.
501,920	July 25, 1893.	J. M. Charnock,	Boston, Mass.
513,943	Jan. 30, 1894.	P. King,	Washington, D. C.
536,456	Mar. 26, 1895.	J. W. Chapman,	Detroit, Mich.
546,089	Sept. 10, 1895.	Cook and Houston,	San. Francisco, Cal.

Reciprocating Tools.

No.	Date.	Inventor.	Residence.
299,893	June 3, 1884.	W. H. Wood,	Woburn, Mass.
305,532	Sep. 23, 1884.	J. A. Panton,	Quincy, Mass.
313,231	Mar. 3, 1885.	J. A. Panton,	Quincy, Mass.
325,675	Sep. 8, 1885.	S. Haley,	Bramley, Leeds, England.
340,713	April 27, 1886.	J. T. Freeman,	Woburn, Mass.
343,552	June 8, 1886.	Tyghe and Howell,	Boston, Mass.
354,178	Dec. 14, 1886.	A. M. Bowers,	Newark, N. J.
363,585	May 24, 1887.	A. M. Bowers,	Newark, N. J.
372,507	Nov. 1, 1887.	G. W. Baker,	Wilmington, Del.
380,239	Mar. 27, 1888.	G. V. Anderson,	" "
391,221	Oct. 15, 1888.	G. V. Anderson,	" "
394,750	Dec. 18, 1888.	G. W. Baker,	" "
405,653	June 18, 1889.	G. W. Baker,	" "
426,225	April 22, 1890.	G. W. Anderson,	" "
441,821	Dec. 2, 1890.	J. A. Brownwell,	Binghamton, N. Y.
443,896	Dec. 30, 1890.	B. D. Chalkley,	Richmond, Va.
451,096	April 28, 1891.	P. W. Whittier,	North Andover, Mass.
479,460	July 26, 1892.	O. Potelune,	Limoges, France.
484,029	Oct. 11, 1892.	L. E. Learoyd,	Danvers, Mass.
486,194	Nov. 15, 1892.	P. W. Minor,	Springville, N. Y.
490,443	Jan. 24, 1893.	F. C. Kimball,	Salem, Mass.
531,462	Dec. 25, 1894.	G. Geyer,	Brooklyn, N, Y.
546,263	Sep. 10, 1895.	I. Vaughn,	Salem, Mass.
559,976	May 12, 1896.	J. Hall,	Leeds, England.
561,583	June 9, 1896.	J. Hall.	Leeds, England.
569,843	Oct. 20, 1896.	H. Smith,	Newark, N. J.
589,123	Aug. 31, 1897.	E. T. Ems,	Philadelphia, Pa.

Rocking Frames.

No.	Date.	Inventor.	Residence.
333,196	Dec. 29, 1885.	E. E. Church,	Beddington, Me.
339,134	April 6, 1886.	A. M. Bowers,	Newark, N. J.
346,900	Aug. 10, 1886.	P. Diehl,	Gloversville, N. J.

No.	Date.	Inventor.	Residence.
365,963	July 5, 1887.	A. M. Bowers,	Newark, N. J.
366,298	July 12, 1887.	" "	" "
367,952	Aug. 9, 1887.	" "	" "
392,004	Oct. 30, 1888.	" "	" "
437,483	Sep. 30, 1890.	T. P. Combs,	Woburn, Mass.
448,422	Mar. 17, 1891.	Gafney and Dawson,	Lynn, Mass.
556,162	Mar. 10, 1896.	T. J. Quinn,	Stoneham, Mass.
589,103	Aug. 31, 1897.	C. A. Southwick,	Peabody, Mass.

Rotating Tools.

No.	Date.	Inventor.	Residence.
292,723	Jan. 29, 1884.	A. Winchester,	Rochester, N. Y.
306,737	Aug. 21, 1884.	M. Garniel,	Paris, France.
387,903	Aug. 14, 1888.	A. Ott,	Milwaukee, Wis.
427,101	May 6, 1890.	P. Monk,	Cincinnati, O.
444,164	Jan. 6, 1891.	J. W. Vaughn,	Salem, Mass.
463,592	Nov. 17, 1891.	W. S. Bacon,	Philadelphia, Pa.
489,641	Jan. 10, 1893.	A. Probst,	Worms, Germany.
491,446	Feb. 7, 1893.	Pullman and Smith,	Godalming, England.
517,424	Oct. 16, 1894.	Hartman and Thomson,	Offenbach on Main, Ger.
527,889	Oct. 23, 1894.	L. and A. Schmoll,	Newark, N. J.
564,511	July 21, 1896.	E. D. Evans,	Bristol, Eng.

Rotary Cylinders.

No.	Date.	Inventor.	Residence.
293,308	Feb. 12, 1884.	A. Cerf. Lanzenburg,	Paris, France.
316,167	April 21, 1885.	F. J. Nelson,	Boston, Mass.
317,770	May 12, 1885.	G. A. Hardy,	Old Lenton, England.
325,431	Sept. 1, 1885.	F. H. Meyers,	Philadelphia, Pa.
327,138	Sept. 20, 1885.	H. R. Churchill,	Buffalo, N. Y.
335,198	Feb. 2, 1886.	W. M. Hoffman,	Buffalo, N. Y.
367,257	July 26, 1887.	A. E. Whitney,	Winchester, Mass.
372,585	Nov. 1, 1887.	J. Wayland,	Newark, N. J.
377,473	Feb. 7, 1888.	G. V. Anderson,	Wilmington, Del.
386,667	Jan. 26, 1888.	H. Thurlow,	Skaneateles, N. Y.
413,601	Oct. 22, 1889.	H. E. Freudenberg,	Wenheim, Baden, Ger.
417,251	Dec. 17, 1889.	Klinik, Penkowski and Gross,	Konigshutte, Germany.
430,165	June 17, 1890.	A. C. Andrews,	Chicago, Ill.
449,707	April 7, 1891.	T. Shaw,	Vanceboro, Me.
451,486	May 5, 1891.	A. R. Huiting,	Salem, Mass.
466,182	Dec. 29, 1891.	E. C. Northrup,	Bodines, Pa.
507,314	Oct. 24, 1893.	W. Evans,	Philadelphia, Pa.
525,372	Sept. 4, 1894.	I. Vaughn,	Salem, Mass.
535,493	Sept. 4, 1894.	W. Evans,	Philadelphia, Pa.
577,402	Feb. 16, 1897.	H. Bright,	Costello, Pa.
580,353	April 6, 1897.	I. Vaughn,	Salem, Mass.

Rolling and Embossing.

No.	Date.	Inventor.	Residence.
294,410	Mar. 4, 1884.	T. Shaw,	Bangor, Me.
295,948	April 1, 1884.	W. A. Sawyer,	Danversport, Mass.
310,160	Dec. 30, 1884.	W. C. Yaeger,	Brownstown, Wis.
311,498	Feb. 3, 1885.	D. Knox,	Lynn, Mass.
312,272	Feb. 17, 1885.	W. W. Hubbard,	Manchester, N. H.

No.	Date.	Inventor.	Residence.
337,935	April 13, 1886.	A. M. Bowers.	Newark, N. J.
356,677	Jan. 25, 1887.	J. Boyle,	Peabody, Mass.
393,486	Jan. 27, 1888.	M. Scott,	Newark, N. J.
444,172	Oct. 6, 1891.	J. W. Vaughn,	Salem, Mass.
447,180	Feb. 24, 1891.	E. Hayes,	Lynn, Mass.
466,083	Dec. 29, 1891.	J. A. Safford,	Malden, Mass.
462,825	Nov. 10, 1891.	M. Scott,	Newark, N. J.
479,460	June 21, 1892.	J. A. Safford,	Malden, Mass.
552,857	Jan. 7, 1896.	M. Scott,	Newark. N. J.

Tables and Frames.

No.	Date.	Inventor.	Residence.
291,882	Jan. 15, 1884.	T. L. Daheny,	Boston, Mass.
333,773	Jan. 5, 1886.	G. Middlemas,	San Francisco, Cal.
340,712	April 27, 1886.	J. T. Freeman,	Woburn, Mass.
352,955	Nov. 23, 1886.	T. W. McKee,	Towanda, Pa.
362,286	May 3, 1887.	G. A. Knox,	Lynn, Mass.
457,014	Aug. 4, 1891.	B. Schnepp,	Louisville, Ky.
547,762	Oct. 15, 1895.	G. F. Bogel,	Altoona, Germany.
584,668	June 15, 1897.	J. A. Brownell,	Binghamton, N. Y.

Tumbling Drums.

No.	Date.	Inventor.	Residence.
302,454	July 22, 1884.	E. S. Ward,	Newark, N. J.
308,755	Dec. 2, 1884.	E. D. Solminehac,	Lorient, France.
313,478	Mar. 10, 1885.	J. Davis,	Allegheny, Pa.
313,542	Mar. 10, 1885.	L. Simpson,	Pittsburg, Pa.
313,543	Mar. 10, 1885.	Simpson and Davis,	Pittsburg, Pa.
314,199	Mar. 17, 1885.	L. Simpson,	Pittsburg, Pa.
314,200	" "	"	"
385,644	July 3, 1888.	W. Schweickhardt,	St. Louis, Mo.
421,249	Feb. 11, 1890.	A. J. Darragh,	Allegheny City, Pa.
461,019	Oct. 13, 1891.	G. Hulseman,	Cincinnati, O.
497,951	May 23, 1893.	J. Davis,	Allegheny City, Pa.

Hides, Skins and Leather.

No.	Date.	Inventor.	Residence.
343,247	Aug. 6, 1886.	E. B. Light,	Denver, Col.
363,546	May 24, 1887.	C. A. Schieren,	Brooklyn, N. Y.
381,932	May 1, 1888.	C. M. Kimball,	Haverhill, Mass.
381,933	" "	"	"
393,845	Dec. 4, 1888.	G. P. McMahon,	Pawtucket, R. I.
400,443	April 12, 1889.	C. W. Cooper,	Brooklyn, N. Y.
408,896	Aug. 13, 1889.	P. Latulip,	Syracuse, N. Y.
451,796	May 5, 1891.	G. W. Baker,	Wilmington, Del.
478,499	July 5, 1892.	T. Burns,	Edinburgh, Scotland.
487,067	Nov. 29, 1892.	J. W. Deckert,	Newark, N. J.
578,257	Mar. 2, 1897.	McKenzie and Shaw,	Cheboygan, Mich.

Leather Working Machinery.

No.	Date.	Inventor.	Residence.
294,320	Feb. 26, 1884.	J. H. Hovey,	Woburn, Mass.
294,394	Mar. 4, 1884.	R. H. Lufkin,	Chelsea, Mass.
297,260	Apr. 22, 1884.	A. Heim,	New York City.

No.	Date.	Inventor.	Residence.
300,812	June 24, 1884.	S. S. Spear,	South Weymouth, Mass.
328,078	Oct. 13, 1885.	A. F. Stowe,	Worcester, Mass.
342,193	May 18, 1886.	C. S. Fifield,	Revere, Mass.
370,068	Sep. 20, 1887.	F. Knox,	Boston, Mass.
386,187	June 17, 1888.	J. J. and G. J. Daley,	Brooklyn, N. Y.
388,419	Aug. 28, 1888.	D. Knox,	Lynn, Mass.
392,113	Oct. 30, 1888.	W. Foglesong,	Dayton, O.
402,060	Apr. 23, 1889.	M. Brock,	Boston, Mass.
402,061	" "	"	"
402,062	" "	"	"
402,069	Apr. 23, 1889.	J. A. Crosbie,	Methuen, Mass.
404,904	June 11, 1889.	C. S. Gooding and S. W. Ladd,	Brookline, Mass.
425,935	Apr. 15, 1890.	F. Bain,	Chicago, Ill.
431,549	July 8, 1890.	M. Brock,	Boston, Mass.
431,561	July 8, 1890.	J. A. Crosbie,	Methuen, Mass.
453,141	May 26, 1891.	M. Brock,	Boston, Mass.
579,468	June 23, 1897.	F. J. Bringham,	Chicago, Ill.

Tanners' Tools.

No.	Date.	Inventor.	Residence.
346,487	Aug. 3, 1886.	A. V. Manly,	Norwich, N. Y.
361,176	Apr. 12, 1887.	J. McDermott,	Middletown, N. Y.
373,748	Nov. 22, 1887.	"	"
427,555	May 13, 1890.	P. S. Connor,	Lake, Ill.
440,240	Nov. 11, 1890.	R. H. Houk,	Morris, Ill.
444,724	Jan. 13, 1891.	H. B. Bryant,	Manchester, N. H.
464,493	Dec. 8, 1891.	H. L. Clark,	Canton, Pa.
470,872	Mar. 15, 1892.	B. Schnepp,	Louisville, Ky.
511,300	Dec. 19. 1893.	W. F. Lawley,	Kennedy, Ala.
511,521	Dec. 26, 1893.	O. Geisler,	Gloversville, N. Y.

Helical Tools.

No.	Date.	Inventor.	Residence.
299,701	June 3, 1884.	J. W. Vaughn,	Peabody, Mass.
310,279	Jan. 6, 1885.	W. M. Hoffman,	Buffalo, N. Y.
311,582	Feb. 3, 1885.	J. Hodskinson,	Salem, Mass.
323,334	July 28, 1885.	W. M. Hoffman,	Buffalo, N. Y.
330,655	Nov. 17, 1885.	A. E. Whitney,	Winchester, Mass.
335,197	Feb. 2, 1886.	W. M. Hoffman,	Buffalo, N. Y.
339,323	April 6, 1886.	J. Rood,	Salem, Mass.
341,977	May 8, 1886.	A. E. Whitney,	Winchester, Mass.
344,068	June 22, 1886.	J. W. Vaughn,	Peabody, Mass.
344,069	" "	" "	" "
363,295	May 17, 1887.	Lichtenburg and Balouin,	Milwaukee, Wis.
373,112	Nov. 15, 1887.	J. W. Vaughn,	Peabody, Mass.
382,262	May 1, 1888.	J. Hodskinson,	Salem, Mass.
383,914	June 5, 1888.	Rood and Vaughn,	Salem, Mass.
401,905	April 23, 1889.	J. Rood,	Salem, Mass.
425,112	April 8, 1890.	J. Straiton,	Bootle, England.
456,421	July 21, 1891.	M. and V. Martin,	Paris, France.
462,838	Nov. 10, 1891.	W. Evans,	Philadelphia, Pa.
441,173	Jan. 6, 1891.	J. W. Vaughn,	Peabody, Mass.
484,146 484,147	Oct. 11, 1892.	W. Evans,	Philadelphia, Pa.

No.	Date.	Inventor.	Residence.
467,216	Jan. 19, 1892.	A. E. Whitney,	Winchester, Mass.
473,039	" "	" "	" "
494,183	Mar. 28, 1893.	" "	" "
497,941	May 23, 1893.	G. W. Baker,	Wilmington, Del.
509,503	Nov. 28, 1893.	A. E. Whitney,	Winchester, Mass.
512,088	Jan. 2, 1894.	G. W. Baker,	Wilmington, Del.
525,052	Aug. 28, 1894.	E. T. Marble,	Worcester, Mass.
526,387	Sept. 25, 1894.	W. Evans,	Philadelphia, Pa.
526,724	Oct. 2, 1894.	C. J. Mayer,	Lynn, Mass.
528,638	Nov. 6, 1894.	G. A. Lawrence,	Peabody, Mass.
535,777	Mar. 12, 1895.	J. Vaughn,	Salem, Mass.
537,254	April 9, 1895.	"	" "
539,104	May 14, 1895.	"	" "
546,868	Sept. 21, 1895.	"	" "
538,944	May 7, 1895.	G. W. Baker,	Wilmington, Del.
540,337	June 4, 1895.	A. Seymour-Jones,	Wrexham, Eng.
541,262	June 18, 1895.	J. Boyle,	Peabody, Mass.
547,984	Oct. 15, 1895.	"	" "
552,628	Jan. 7, 1896.	A. E. Whitney,	Winchester, Mass.
552,791	Jan. 7, 1896.	R. Steyer,	Dohna, Germany.
556,813	Mar. 24, 1896.	W. Evans,	Philadelphia, Pa.
569,136	Oct. 6, 1896.	A. F. Jones,	Salem, Mass.
570,653	Nov. 3, 1896.	A. E. Whitney,	Winchester, Mass.
572,532	Dec. 8, 1896.	W. Evans,	Philadelphia, Pa.
572,533	" "	"	" "
578,309	Mar. 9, 1897.	G. W. Baker,	Wilmington, Del.
583,995	June 8, 1897.	J. Hall,	Leeds, Eng.
587,717	Aug. 10, 1897.	W. Evans,	Philadelphia, Pa.

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